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A Message From The Administrator

The Argo Merchant oilspill that occurred in late December and early January gave NOAA its first major opportunity to test its mechanisms for quick response to such events. The people of NOAA did a splendid job, working in difficult weather and over holidays. They performed research and modeling tasks, they looked at the effects of the spill on fisheries resources and the industry, they carried out environmental monitoring and public liaison duties, and they accomplished these many tasks with care, dispatch, and imagination. They also gave invaluable support to the Federal On-Scene Coordinator, and continued the NOAA tradition of close cooperation with the Coast Guard.

The Department of Commerce, through NOAA, is a primary agency in the Federal Contingency Plan for combatting spills of oil and hazardous substances. We are also charged with acquiring information on the impact of pollution on fish, and we are interested in creating the necessary data base for coastal zone management and planning and for marine ecosystem impacts, as well as environmental forecasting. Consequently, NOAA must constantly seek to improve its capability both for quick response and for long-term assessment, in order to learn as much as possible about short- and long-term effects of such oil spills. We must be in a position to render necessary aid to the fishing industry, including restoring damaged habitats as quickly as possible. We must also make certain that the research tools we use will provide information needed for better management of our coastal and marine resources, and of the technology that affects them.

Through the Argo Merchant and other more recent incidents, NOAA has demonstrated the breadth of its capabilities and resources. We should now draw upon our experiences and our talents, so that in future events of this nature, we can better assist other agencies working under the National Contingency Plan and we can better discharge our own diverse statutory responsibilities. In this way our response will be ever more meaningful, building upon the excellent example provided us by the NOAA units involved in the case of the Argo Merchant.

Robert M White

THE MYSTERY OF THE BEACHED MAMMALS

By THOMAS M. LEAHY*

THE discovery of the carcasses of 17 false killer whales at an isolated spot in Southwest Florida in August 1976 marked the end of a strange series of events that still have marine scientists puzzled. The whales, found at Cape Sable in Everglades National Park, had been dead for several weeks, and their bodies were badly decomposed, but it was thought that they were part of a pod of whales involved in three other mysterious mass strandings of marine mammals during a two-week period in July.

The mystery began to unfold on the night of July 13 off Casey and Siesta Keys, small barrier islands off the southwest coast of Florida near Sarasota. Residents of the area reported hearing high-pitched sounds, almost like bird cries, about 10 P.M. and seeing a pod of between 50 and 150 dolphins heading for the beach. These were the air-breathing mammals about 6 feet long and 150 pounds, not the smaller, spiny-finned fish that have the same name.

By hand and with motor boats, people in the area worked all night in an attempt to turn the animals back to sea. Also on hand were officers of the Florida Marine Patrol and agents of the National Marine Fisheries Service who are responsible for protection of the species under the Federal Marine Mammal Protection Act. Despite all efforts, 25 of the pod died. Although they are air-breathing mammals, they have difficulty breathing when they are not surrounded by water. Also, their skin dries quickly and cracks.

Dr. James Mead, curator of marine mammals at the Smithsonian Institution, who has studied more than 100 mass strandings of whales and dolphins, was notified and came to the scene. Under his direction the dead animals were brought to the nearby Mote Marine Laboratory on the southern tip of Siesta Key.

There the mammals were identified as *Stenella longirostris*, or spinner dolphins—deep water mammals that usually stay at least 10 miles from shore, and are somewhat smaller and different in appearance from the Atlantic bottlenose dolphin, or porpoise, that has a snub nose, frequents the Florida shoreline and inlets, follows ships, and stars in shows at marine attractions. Their sudden appearance on the Florida gulf coast was a rare event according to Mead, and the first mass stranding of this particular species that he was aware of.

Working with Mead were Ed Aspar, curator of mammals and birds at Sea World of Florida, and other researchers from that marine attraction near Orlando; Dr. Daniel Odell from the Rosenthiel School of Marine and Atmospheric Science, University of Miami; Drs. Robert Schimpff and Nicholas Hall, neuroscientists from the University of Florida, and Carroll Woodard, veterinary pathologist, also from the University of Florida. Schimpff, chief of neuropathology at the university's health center, is also a principal investigator for the Florida Sea Grant Program and through an immediate-response grant has been conducting neuropathologic work on the brains of cetaceans.

After working for two days performing necropsies on the dead dolphins, the scientists could find no apparent cause for the stranding. In his earlier work, Mead has shown that a related species, the pilot whale, is prey of a parasitic worm which infests the middle ear sinuses, the nervous system and the brain, causing extensive damage. This impairs the echolocation system and food finding capabilities causing the animal to become disoriented and to head for shore followed by the others in the group.

He felt that this might also be the reason for the stranding of the Casey Key dolphins and that the cause of impairment of their navigational and directional abilities could have been obtained from a common food source. However, after the necropsies had been performed, he admitted that there was not a clear-cut case. Eyes, brains, and digestive tracts were taken by the researchers to their laboratories for further analysis.

Two survivors from the pod were brought to the lab but reportedly had lost their "sonar" capability which caused them to swim into the walls of the natural pen. They were kept there 24 hours and were then taken to Sea World for further tests and observation. They died a short time later.

According to Aspar, the animals were healthy but were suffering from what he termed a "stranding shock syndrome," and they never recovered from it. Sea World tried medication and drugs, but they had no effect.

"They would not even swim or support themselves at all," Aspar said. "We had to build canopy stretchers and support them in

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**Thomas M. Leahy is an editor with the Florida Sea Grant Marine Advisory Program.*

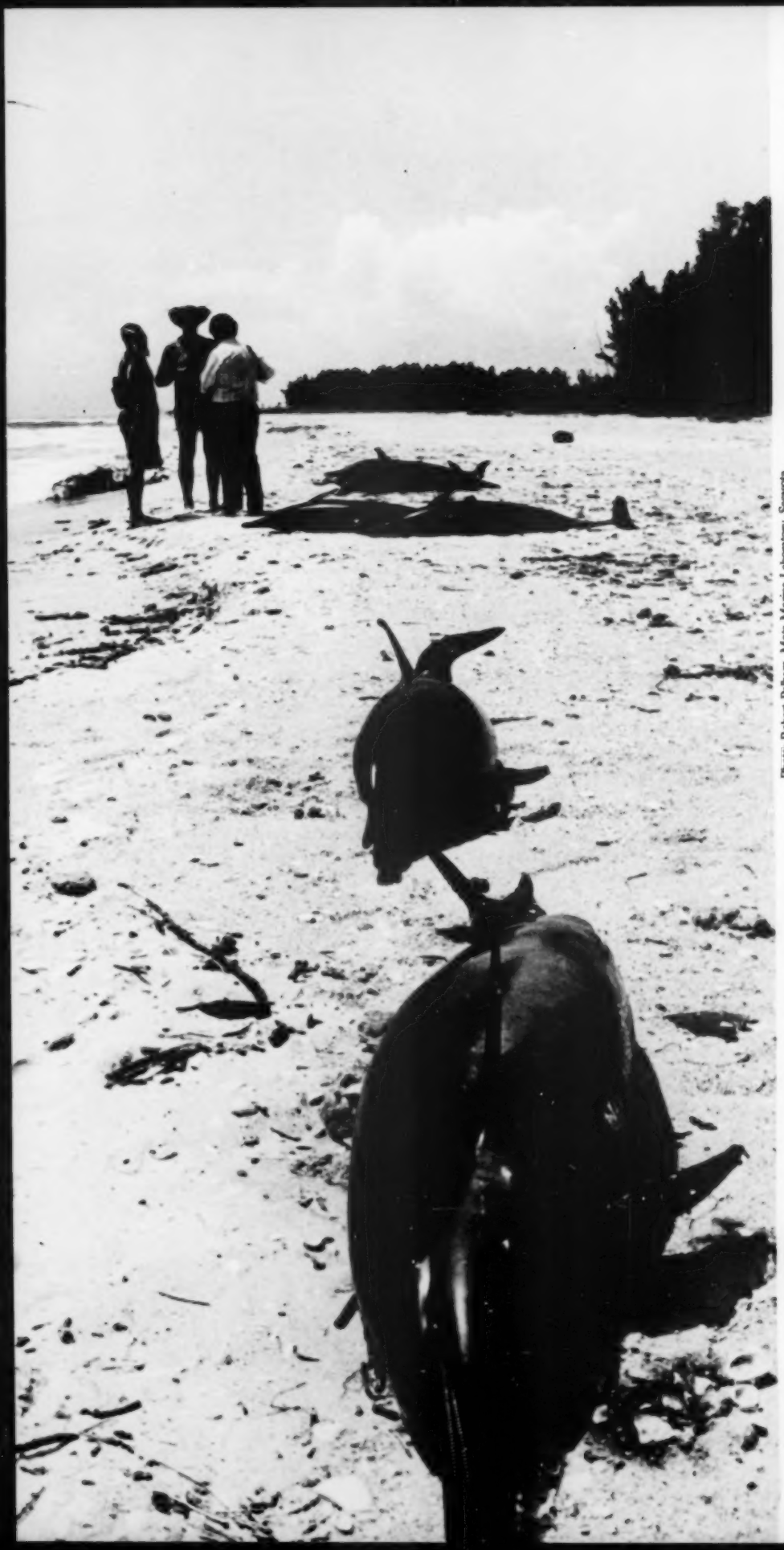


Photo: Robert Pelham, Mote Marine Laboratory, Sarasota

the water to keep them afloat. Mentally those animals had died. But as far as their necropsies went, those animals looked very, very good."

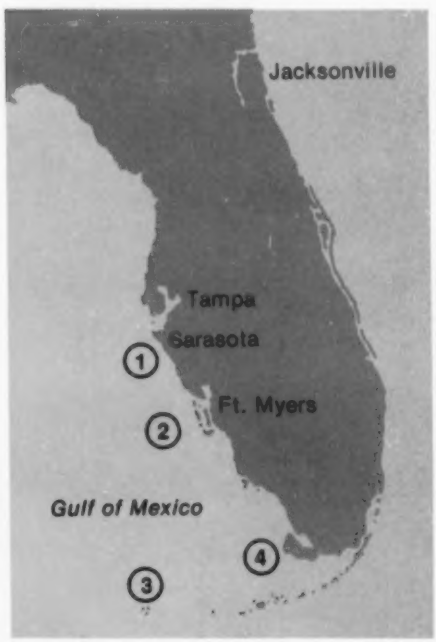
Nine days later, on July 22, another mammal beaching occurred about 50 miles farther south. This time the animals were five whales, at first thought to be pilot whales, and they had beached themselves on sandbars in Pine Island Sound near upper Captiva Island in the Fort Myers area.

Again rescue teams made up of marine experts, doctors, area residents, and Florida Maine Patrol officers worked to free the large mammals from the shallows, walking along behind them in two or three feet of water to keep them upright and moving. They rubbed grease on their bodies and applied wet towels to protect them from the sun.

Aspar, who had brought a crew from Sea World to aid in the rescue work, identified the whales as *Pseudorcas*, false killer whales, a porpoise-like mammal 13 to 16 feet long, weighing 1000 to 2000 pounds, and very rare on Florida's gulf coast.

One whale in the group died and Odell, who had come again from Miami, performed an autopsy. He reported there was no food substance in the intestines and stomach and that those organs showed the presence of a type of parasite. The preliminary findings, he indicated, were similar to those of the Casey Key dolphins.

The other four were taken to Sea World for tests and observations. They were determined to be suffering from internal problems as supported by the death of the largest one. Lung worm infestation was found in the oth-



Dead dolphins litter the beach at Casey Key the morning after a stranding (left). Map shows areas of strandings: (1) Siesta Key-Casey Key; (2) Captiva Island; (3) Loggerhead Key; and (4) Cape Sable.

ers and they also subsequently died.

The beachings were not yet over. Just three days later, at Loggerhead Key, a tiny island in the Dry Tortugas about 65 miles west of Key West, 24 false killer whales beached themselves, followed the next day by six more. Rescue workers managed to head all but one out to sea where the Coast Guard officials reported them swimming east toward the Atlantic Ocean.

Again Odell and Aspar were present as were Schimpff, Hall, and Woodard. This time the University of Florida scientists were able to secure the brain of the dead whale within two hours after death, insuring that it was in excellent condition.

This rapid response was made possible due to emergency funding by the Florida Sea Grant Program from immediate-response funds. Hall had been back in Gainesville only one day when he received the report of the Loggerhead beaching. He called Dr. Hugh Popenoe, director of the Florida Sea Grant Program, who agreed to underwrite the expedition. Hall chartered a plane and he and Woodard left a short time later with two others, stopping on the way to pick up Schimpff who was still at Captiva Island.

Aspar credited the success of the Loggerhead Key rescue in large part to Tom Maher of the National Marine Fisheries Service, who organized the activity under advisement from the Florida Marine Patrol and researchers on the island.

"His approach to the problem permitted us the latitude to accomplish our work efficiently and quickly," Aspar said.

A new technique suggested by Aspar was used to move the Loggerhead Key whales. A human chain of ten men was formed to begin herding the animals toward the surf. Once in the water, two boats and a tow rope suspended between them were employed to further herd the whales. The men swam the first mile with the whales, swimming with tennis shoes on to prevent slashing their feet on razor-sharp coral, and some literally riding the backs of the animals. The animals had to be shoved and pushed toward the deep water and time after time the pod of whales would turn back toward shore. After one mile the bottom dropped more steeply to 30 feet and the animals began to sense they were heading in the right direction.

With permission from Maher on behalf of the National Marine Fisheries Service, researchers were able to study the entire pod of whales. Each one was photographed individually with measurements taken, documentation of dorsal fins made, 80 to 90 blood samplings arranged, tissue samplings made from the one animal that died, and parasitic conditions biologically studied.

After four years without any mass strandings of mammals, three groups had beached themselves within a two-week period. Since the Cape Sable whales had been dead for several weeks when found, their stranding would have occurred about the same time, thus raising to four the number of marine mammal strandings during that period in July. But their discovery seemed only to compound the mystery.

Human interest in the dolphin and its larger relative, the whale, is nothing new. Throughout the ages people have been fascinated with these animals, particularly the delightful, playful, gentle dolphin that breathes air, yet lives in the sea. Twenty-nine hundred years ago the ancient Greek poet Homer wrote of the dolphin. Accounts appear in the fables of Aesop and in the writings of the ancient Greeks including Plutarch, Euripides, Aristophanes, Plato, and Aristotle, and the Romans, including Ovid and the Plinys, the Elder and the Younger. In song and story, folklore and fantasy, from the ancient scribes to modern writers, all have marvelled at the special traits of the dolphins—their incredible speed, intelligence, hearing, general trainability and friendliness to man.

"Though it has no need at all of any man," Plutarch wrote of the dolphin, "Yet is a genial friend to all, and has helped many."

The first recorded contact between man and dolphins is thought to be that of Aristotle

Photo: Courtesy of Stephen Letherwood

whose account of the dolphin's anatomy and behavior is considered to be fairly exact, even distinguishing between the dolphin of the Mediterranean and the porpoise of the Black Sea. Though his writings do not indicate that he ever dissected one, he notes that they have lungs and a windpipe instead of gills, that they give birth like the land animals, and suckle their young with milk. He noted, too, that though they had no visible ears they could hear sounds in the water, made squeaking noises when taken from the sea, swam rapidly, and jumped into the air.

The ancients believed that dolphins had once been men and a Homeric Hymn describes the legend of the creation of the dolphin. According to the legend, Tyrsenian pirates kidnapped Dionysus, son of Zeus, and were taking him to Asia to sell as a slave. Threatened by Zeus for their actions, and finding their ship suddenly filled with vines and running with sweet wine, the sailor-pirates became crazed, jumped into the sea, and were turned into dolphins. This story was retold by Ovid, with Dionysus called Bacchus in the Roman way.

Another story has Pharaoh's forces turning into dolphins while pursuing the Israelites into the Red Sea thus being doomed to roam the seas until the end of time. Later dolphins were described by Bacchylides of Ceos as "sea people" and today dolphins are considered as land mammals who long ago, perhaps as long as 60 million years ago, chose to return to the sea, their bodily configuration gradually evolving to be adaptable to the environment until it became streamlined and fish-like in appearance. X-rays of the dolphin's flippers show small bones representing what used to be hands.

Strandings of dolphins play a part in stories passed down through the years. Not having scientific knowledge, the ancients tended to attribute human motives to animal actions that probably had a more plausible natural explanation. Many of the stories seem to center on the dolphin's attraction for a particular child, following the child too far up on the beach and then dying because it was unable to return to the water, or the child's drowning inadvertently while riding on the dolphin's back and the dolphin, distraught over the death, beaching itself to share death with the child. Similar stories abound from different times and places.

Stranded whales have been around for a long time, too, with one theory being that the first "whaling" was done by just taking advantage of whales already stranded on beaches, and that not until years later did man begin to chase the animals on the open sea.

Always present to some degree throughout the years has been the belief that there is in the marine mammal, whale and dolphin alike, some latent memory mechanism at work, which perhaps drives it to return to the land from which its forebears had come.

Plutarch, in his writings, called the strandings "suicide," and even today that notion arouses a lot of interest, but scientists generally tend to discount that possibility.

So what is the answer? Even with sophisticated scientific methods and equipment and with knowledge greatly exceeding that available to Aristotle and those of his time, marine scientists today are not completely certain what causes these mammals to apparently deliberately throw themselves up on the beach to die. This holds true also for the mysterious and unprecedented Florida strandings although now, months later, more information is available.

As far as the spinner dolphins are concerned, no evidence of organic disease which would have caused their stranding was found in the initial necropsies and subsequent examinations of the organs has failed to uncover anything significant.

In a report issued by the health center at the University of Florida in January 1977, Schimpff, Hall, and Woodard indicate that they found no evidence of such brain disorders or parasitic infestation in the Casey Key dolphins which would have contributed to the stranding.

Their findings agree with those of Ed Aspar (at Sea World) who reported that the necropsies on the two dolphins that died there were "very good" and that nothing has turned up since the stranding which would explain it. He believes it was because they accidentally came too close to shore.

"The only thing you might be able to correlate," he said, "is confusion by the animals by their pelagic status being more or less entrapped, either by mistake or otherwise, in a shallow bay area."

He explained that a shallow sloping sandy beach or even a mud bottom tends to absorb the sound. "If they don't get a feedback, there is a good possibility that their impression is that there is deep water ahead," he added.

As to what might have brought the dolphins in to shore, Aspar said they may have been following food, speculating that perhaps a lack of it in their normal environment caused them to search in a wider range.

"Why they would turn in there (Casey Key) is probably pure happenstance," he said.

Dr. Perry W. Gilbert, director of the Mote Marine Laboratory, agrees with Aspar's explanation, feeling they may very well have been following a food source into the area and then have become confused because of the long sloping continental shelf on the Gulf coast.

The false killer whales are a different story. Hundreds of inch-long parasitic worms were in the ear canals of the Loggerhead Key casualty, but Odell felt at the time that there was not sufficient organic damage to have caused him to become disoriented and to head for shore.

On the other hand, Aspar reported that the four whales that had died after being taken to Sea World from Captiva were heavily parasi-

Photo: AP Wirephoto

With the help of two assistants, Dr. Mead (above) checks on dead whales near Mayport, Fla. where more than 100 mammals beached themselves. Strandings are not limited to the United States. Photo at left shows beached whales and dolphins at Arikawa Bay in the East China Sea.

Photos: Robert Pelham

Photo: Nancy M. Hamilton

Scientists at Mote Marine Laboratory place surviving dolphins in a pen in an effort to save them (top). Dr. Perry W. Gilbert, Director of the Mote Marine Laboratory (left), and Dr. James Mead, curator of marine mammals at the Smithsonian Institution (below).

tized and suffering from lung worm infestation. He feels that this condition would probably have caused them to beach themselves.

"But that question, again, will probably never be answered," he said. "We had the opportunity to look at only six of the animals—the four that died here, one that died at Captiva, and one at Loggerhead Key."

Meanwhile, at the University of Florida, Schimpff, Hall, and Woodard are not finished with their detailed examination of brain of the Loggerhead Key whale, and are not yet prepared to connect the parasites with the stranding.

But it appears that at least one important question has been cleared up. Aspar said that it has now been determined that the false killer whales involved in the strandings were all part of the same pod or herd. Five tried to beach themselves at Upper Captiva Island, 30 at Loggerhead Key, and 17 about a week later at Cape Sable. The whales at Loggerhead Key had been tagged, but by the time those that died at Cape Sable had been found, the bodies were so decomposed and damaged from apparent shark attacks, that the tags were no longer available. It was doubtful at first if it could ever be determined definitely that they were part of the Loggerhead Key whales.

"But one or two of the animals in that group were positively identified by photographs," Aspar explained. "One in particular had live barnacles growing on the upper and lower jaw of the right hand side, and that skull was found; and there was another one that was not quite so decomposed that matched the photographs. They have been identified by photographs from all three places."

The theory that the leader of the herd, usually the biggest bull whale, becomes ill and through disorientation or some other reason comes into shore bringing the others with him, has some validity, Aspar believes.

"But all we can do with these false killer whales is speculate at this point," he said. "We do not know what happened to the rest of the 29 animals, 17 of which died in the Everglades. The others may have made it or they may have washed up outside the jurisdiction of the United States—Cuba for example, or someplace else—and we'll never know that. So we don't know if the animals that were recovered are any indication of what was affecting the entire pod—or was the entire pod remaining in good health and only following the animal that led them in? Now the one that died in the Dry Tortugas happened to be the biggest male in the entire group. And that animal did have a lot of parasites in the inner ear which we think may throw these animals off course. Since the remaining 29 were not sampled, we have no way of saying if they were affected or if they followed."

Aspar further related that in getting the whales off the beach and into the water at Loggerhead Key, attempts to select the five largest bull whales and start them out into the deeper water failed on several occasions, although different animals were selected each time. Not until all the whales had been turned around and were headed out were they successful. As long as at least one of their group remained the others would not leave the area.

Gilbert, however, in commenting on this theory, feels that it was disproved during a prior stranding of pilot whales on Boca Grande on August 20, 1971.

"In that stranding the large bull whales remained offshore while the smaller members of the herd beached themselves," Gilbert said.

The matter still remains, then, largely a matter of speculation, with no evident organic illness to account for the stranding of the spinner dolphins on Casey Key, and the most likely explanation being that they became disoriented due to finding themselves in unfamiliar shallow waters. Parasite infestations and other organic causes may have triggered the whale strandings but whether all the whales were affected or whether it was only a few with the rest following along will also probably never be known about this particular pod of false killer whales.

To some extent, then, we have not progressed much further than the wisdom of Aristotle who wrote concerning marine mammals over 2300 years ago: "It is not known for what reason they run themselves aground on dry land; at all events, it is said that they do so at times, and for no obvious reason." □

NOAA AND THE NANTUCKET OIL SPILL

AT 7 a.m. Wednesday, Dec. 15, 1976, the tanker Argo Merchant, carrying 7,700,000 gallons of heavy No. 6 fuel oil, ran aground 29 nautical miles southeast of Nantucket Island. At 1 p.m. that day Elaine Chan of the Environmental Data Service was notified of the grounding and of the possibility that a major oil spill could occur. By 9 p.m. she and Gary Hufford of the Coast Guard Research and Development Division, Groton, Conn., had arrived in Hyannis, Mass., and established the headquarters of the NOAA/Coast Guard Spilled Oil Research (SOR) team.

Meanwhile, that same afternoon:

—Craig Hooper of the Environmental Research Laboratories, SOR Program Director, packed his gear and boarded a plane at Boulder, Colorado;

—Dr. James Mattson, who like Chan is with EDS' Center for Experiment Design and Data Analysis (CEDDA), sauntered out of a law examination in Orlando, Fla., picked up a telephone message, and hurried north;

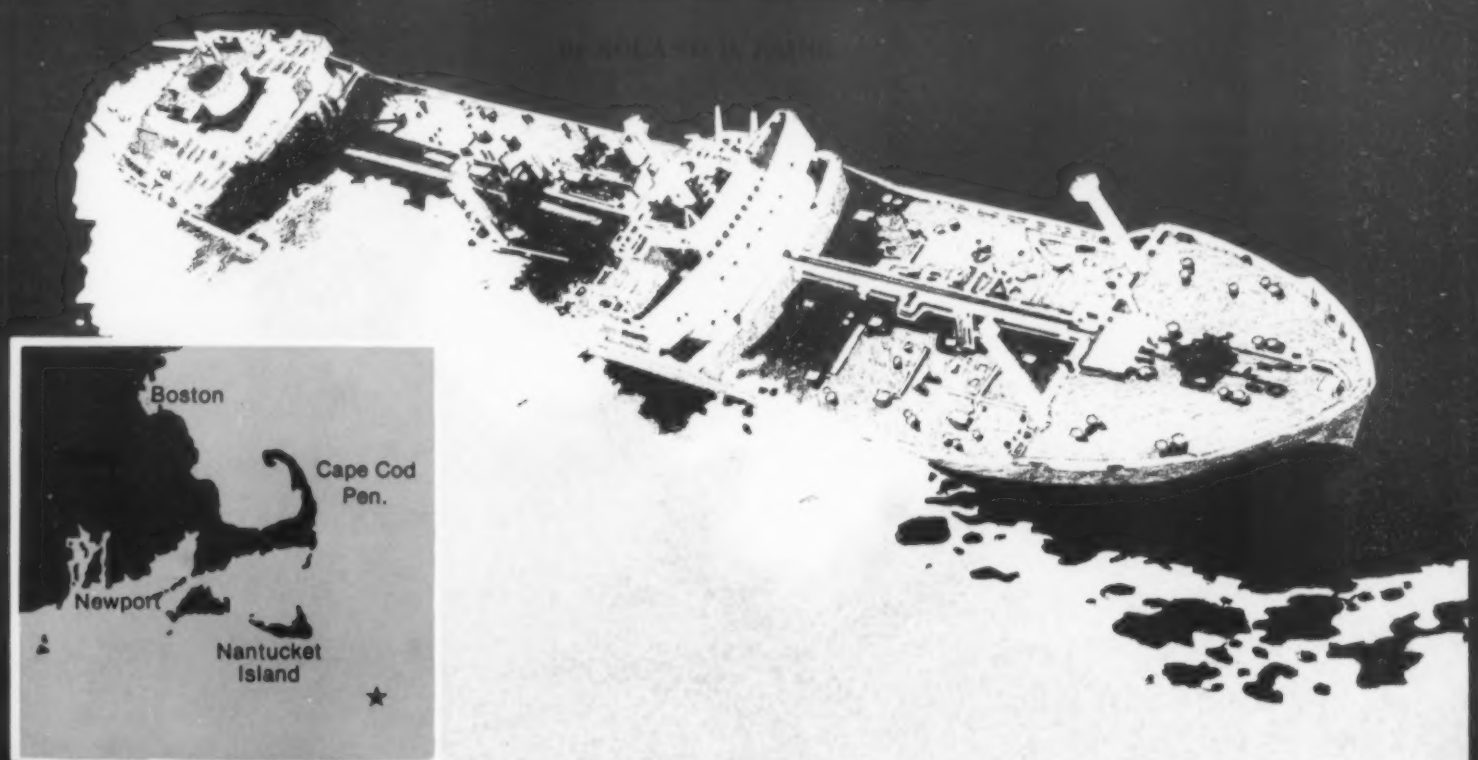
—Dr. Peter Grose of CEDDA interrupted a long-planned family Christmas trip, collected suitcases and scientific instruments, and started for Boston;

—Sue Lease of ERL/Boulder, who was on her way to Juneau with equipment for an Alaska-based oil spill team, was located in Seattle and turned around;

—Anthony Tancreto, Meteorologist-in-Charge of the National Weather Service office in Boston, issued the first of innumerable special marine forecasts directly to the Coast Guard.

The following morning Hooper, Mattson, and Grose met in Boston's Logan Airport, where they were given an airline flight lounge to use as telephone headquarters. By 1 p.m. they too were in Hyannis. Lease joined them two days later.

The SOR team had been designed by Hooper as a quick-response unit, and, holidays notwithstanding, its members reacted as planned. During the succeeding days the orig-



Aground on Nantucket Shoal, Argo Merchant leaks oil as heavy weather approaches. Location of the grounding, off Cape Cod and 29 nautical miles southeast of Nantucket Island, is shown above.

inal group was joined by many other people from NOAA, the Coast Guard, the State of Alaska, and colleges and universities. All were eager to help monitor what was to become one of the largest oil spills in U.S. history, and track and assess its potential for environmental damage. Averaging about 15 people, and numbering at times as many as 25, the team worked for more than three weeks, through Christmas and the New Year, finally tapering off on January 9, 1977, to a small monitoring group of five.

The notion of quick-response teams to carry out research on oil spills arose as a result of work NOAA is doing for the Department of the Interior's Bureau of Land Management. In May 1974 BLM asked NOAA to undertake research leading to an environmental assessment in the offshore waters of Alaska, in anticipation of future oil and gas lease sales and subsequent development. NOAA established an Outer Continental Shelf Environmental Assessment Program (OCSEAP) at its Boulder research laboratories to manage the program.

Two major objectives of the project are to find out what influences the fate of spilled oil on the surface of the water, in the atmosphere, and in the water column; and to determine the physical and chemical changes in the oil slick as time passes. OCSEAP initiated an extensive series of studies of these problems, involving both observation of actual spills and computer modeling of oil spill behavior. The research is aimed at producing models by which the direction and speed of oil movement during future spills, and the impact of the oil on the immediate environment, can be predicted, under a variety of environmental conditions.

All this requires that, when an oil spill occurs, somebody—several somebodies—must be prepared to drop routine work, interrupt personal plans, get to the scene as quickly as possible, and study—carefully and scientifically—just what is happening.

OCSEAP, under Hooper's leadership, began to form teams to accomplish this—four of them, two in Alaska, one in Seattle, one in Washington, D.C., and with a small back-up group in Boulder. The research capabilities of ERL and the data management capabilities of EDS made it natural that the cadre of the teams were provided by these two organizations. The State of Alaska and the Coast Guard also provide team members, and close liaison has been established with the Coast Guard's National Response Center in Washington.

Equipment packages were assembled containing supplies sufficient for at least 48 hours of oil spill tracking—specially modified cameras, drift cards printed in three languages, inflatable markers, sample bottles, current probes, and many other items. They were to be kept readily accessible at each of the four locations. This was the equipment that Sue Lease was taking to Alaska, until the call came that sent her to Massachusetts instead.

So when Elaine Chan received a telephone call on Dec. 15 from Yates Barber of the National Marine Fisheries Service, telling her that a major oil spill was impending, the mechanism was in place and the team members trained. Meeting the test that was to follow, the severest yet faced, required almost the full strength of all four oil spill teams plus major assistance and cooperation from many other people and organizations, within and outside NOAA.

Capt. Lynn Hein, USCG, Federal On-Scene Coordinator, examines oil slick charts at SOR team headquarters.

In the cold dawn of Dec. 16 Chan and Hufford took off in a small aircraft that they had hastily chartered upon their arrival in Hyannis the previous evening. Visibility was about 1000 to 1200 feet, the tanker was leaking oil, and her starboard side was awash. Chan and Hufford took photographs, observed the leaking oil, and dropped probes to obtain information on surface currents in the vicinity of the grounded tanker.

Below them were the Coast Guard cutters Sherman and Vigilant, and two Coast Guard helicopters putting pumps, fuel bladders, and other equipment aboard the Argo Merchant. The Coast Guard's Atlantic Strike Team was aboard the tanker completing removal of the crew and continuing efforts to try to refloat the ship.

"The Coast Guard directed air traffic at the scene, and was immensely cooperative in helping us get our work done," said Chan. "We were able to deploy one current probe very close off the starboard bow of Argo Merchant. As a bit of luck, too, right after the two die markers surfaced the Vigilant moved between them, and since we knew her length we had a perfect scale for our current measurements."

They observed the oil coming from the ship, and noted that it was floating all around the tanker instead of trailing off in one direction. "This indicated to us that the oil was under tidal current influence," Chan said.

Hooper, Mattson, and Grose came in from Boston shortly after noon, and in the afternoon made their first aerial reconnaissance of the extent of the slick. That evening the five team members went to the Coast Guard air station at Otis Air Force Base, to confer with the Federal On-Scene Coordinator and to be briefed on the operational situation. Hopes were high that enough oil might be pumped out of the ship to refloat her, and the team members thought that they might get home for Christmas.

But the weather continued to worsen. That evening the Coast Guard lost the battle of the pumps, and had to abandon ship. "They lifted 16 people off the Argo Merchant by helicopter in gale force winds, at night," said Mattson. "The Coast Guard helo pilots are tremendous—the support they gave us throughout the whole operation was almost unbelievable."

The SOR team received an unexpected and welcome addition at the time of the visit to Otis, in the person of Joseph Deaver, Coast Guard oceanographer, who was engaged in a long-term aerial survey of the Gulf Stream. Forced into Otis by the foul weather, he promptly joined up, stayed with the team for three weeks, and made almost daily flights in a Coast Guard HU-16 seaplane to chart the oil spill areas and obtain surface water temperature data.

During the day team members found time

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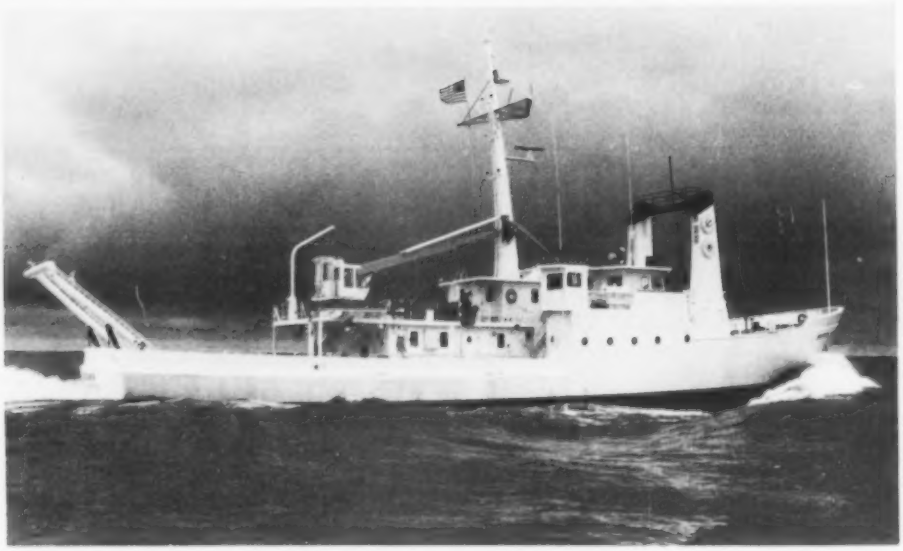


Photo: University of Rhode Island

Photo: Frank Medeiros

Two research ships that joined with NOAA scientists assessing the effects of the spill—the University of Rhode Island's Endeavor (above) and the Woods Hole Oceanographic Institution vessel Oceanus.

to telephone Government agencies and academic institutions in the area with urgent requests for research ship time, and the first to respond were the Woods Hole Oceanographic Institution and the University of Rhode Island. On Dec. 17—a nasty day with a heavy overcast and rain showers alternating with snow—Hooper, Mattson, and Chan went down to Falmouth, where late in the afternoon they briefed WHOI staff members on the situation and on their needs. Much later that evening, back at Hyannis, they met with Dr. Mason Williams and Dr. James Quinn of the University of Rhode Island, talking and planning until well into the morning hours for a later cruise by URI's ship Endeavor.

As a result of the afternoon meeting the Woods Hole Oceanographic Institution made its research vessel Oceanus II available, called the ship back to port, installed new scientific gear and a new scientific team, and sent her out to conduct the research agreed upon with the SOR team. Dr. Jerry Galt, a physical oceanographer with NOAA's Pacific Marine Environmental Laboratory, flew in from Seattle on Saturday to join the team and departed on the cruise on Monday. His quick response, incidentally, meant that he missed seeing his sister, who lives in Taiwan and had come to Seattle to spend the holidays with him.

Dr. John Milliman of WHOI was chief scientist for the Oceanus II cruise, which included several other top WHOI scientists—Drs. John Farrington, John Teal, and Howard Sanders. Richard Jadamec of the Coast Guard research and development center in Groton responded to a telephone call and also joined the cruise. He is experienced in taking sterile bag samples, lowering the samplers through the oil slick, obtaining water samples below it, and then bringing them back up through the slick without contaminating them. Jadamec later analyzed the water and sediment samples taken by Government and university ships during the spill.

The ship occupied three scientific stations northeast of the known spill area. Sediment samples were taken for baseline information in case oil sank to the bottom with consequent degradation of the environment of bottom-dwelling organisms, and water samples for hydrocarbon anaysis were taken at three depths at each of the stations. Even though foul weather, with blowing snow and 20 foot seas, forced an early halt to the cruise, it proved to be very helpful to the SOR team and to other scientists working on problems of the oil slick.

By Saturday, Dec. 18, hard aground on the rocky shoal, Argo Merchant was beginning to show signs of the battering she was taking. The Coast Guard reported her listing at 20 degrees, with geysers of oil shooting upward, large amounts of oil spilled, and a heavy oil plume extending 7½ miles from the vessel. An SOR team overflight showed an oil slick extending seven miles to the northwest, reaching toward the beaches of Nantucket Island. Oil "pancakes"—thick, flat, cohesive masses of oil floating amidst the thinner slick—were observed 27 miles to the east, and team members measured surface currents in both areas with air-dropped probes to get a better understanding of the forces working on the oil, and to enable them better to predict further oil movement.

By the following day the slick stretched out from Argo Merchant in a huge horseshoe, 36 nautical miles long. The Coast Guard reported that an estimated 1.5 million gallons of oil had entered the sea, and that the tanker was settling into the sand. Huge supertanker fenders were rigged alongside the ship that day, by an Army "sky crane", with the hope of taking off the oil.

The NWS special marine forecasts begun by Tancreto the first day were invaluable tools for the Coast Guard. Every six hours they came, night and day, predicting wind speed and direction and sea state.

SOR team members made overflights by helicopters and chartered aircraft, measuring currents, sampling the oil, mapping the slick, and measuring the difference in velocity between water and oil. The National Aeronautics and Space Administration and the Environmental Protection Agency also conducted overflights of the scene. The NASA aircraft took false-color infra-red photographs of ship and oil slick that were soon provided to the SOR team for their use.

During the four-day period ending on Sunday Professor Jerome J. Milgram and Dr. E. Kern of the Massachusetts Institute of Technology Sea Grant program visited the Argo Merchant to study first hand the dispersion, spreading, and mass transport of the oil slick, and to obtain oil and water samples for laboratory analysis. Milgram was able to take one 16 ounce sample, which he shared with the University of Rhode Island. It was later learned that there were *two* No. 6 fuel oils (the so-called "Bunker C" heavy industrial oil) in the cargo of Argo Merchant, 50,000 barrels of one and 139,000 barrels of the other. Their viscosities are very similar, and the team is trying to find out which cargo was in which tanks, to further identify the sample taken by Milgram.

By the time the weekend was over, men

and women from the four oil spill teams, and many other interested people, had responded to calls for aid and flocked to Hyannis to help. Most of an upstairs wing of the Holiday Inn had been taken over for the project. A large room, with beds removed, served as operations headquarters and message center. It was provided with four telephones, bulletin boards, a conference table, and a davenport and armchairs. Dresser drawers, neatly labeled, contained cameras and film, drift cards, water samplers, and other equipment. A small adjoining room served as secretarial headquarters, and also contained a plotting table.

A few doors away Grose and the Environmental Data Service group established a small data collection office, with light table, charts, files, and supplies. Adjoining it, Rosalie Redmond of ERL/Boulder operated a magnetic-card automatic typewriter and associated equipment. Most of the scientific equipment, when not in use, was stored in closets and on the floors of rooms occupied by the team members responsible. For several days a stairwell that housed vending machines and an ice-maker also served as storage room for a bright orange data buoy.

Early each morning there were hasty conferences and briefing sessions, as team members prepared for their day's work, checked the equipment they would need, and made ready for flights in Coast Guard helicopters or fixed-wing aircraft, or in smaller planes leased by the project or provided by contractors. As the groups left in twos and threes, those remaining would begin to use the telephone—efforts to locate equipment or services from local merchants (who proved to be immensely cooperative and cheerfully ready to extend instant credit), calls to NOAA headquarters and installations around the country for specialized assistance, liaison with the Coast Guard, consultations with scientists who might offer helpful suggestions, and so on. Incoming calls kept team members busy answering queries about the latest position of oil slicks, potential danger to fish or marine mammals or beaches, and the most recent weather at the site.

A couple of transplanted meteorologists, Katherine Kidwell and John Carlile, both of EDS, made regular overlays of a National Ocean Survey chart of the area, so that team members and others could instantly check the current position of the oil slick and its movement from the time the ship went aground. Carlile also kept a complete photographic file, identifying each slide by date and with other pertinent information, thus providing a continuous record of the spill.

Late in the afternoon those returning from flights or ship cruises would phone their most recent observations, and as evening approached they would drift in, brief Grose and Mattson, provide data and photo rolls to the EDS office, write their reports, and relax to exchange information and experiences with others.

Frequently in the evening an overall debriefing and summing up of the day's activities would take place, and plans would be made for the next day's work. Coast Guard Capt. Lynn Hein, Federal On-Scene Coordinator, and Cdr. Barry Chambers, head of the Atlantic Strike Team, were participants in many of these conferences.

The basic scientific objectives had been laid out in some detail three months before. After consultations among the individuals initially identified as members of the teams, an operations plan was agreed upon that spelled out organization, operational procedures, equipment, and scientific observations and measurements to be made. Primarily, said the plan, teams would measure the physical movement of various classes of oil at sea under diverse oceanographic and meteorological conditions, the purpose being to test existing oil spill trajectory models.

The team later noted: "While there are available many time-series photographs of spills in cold water environments, these spills have not been adequately instrumented and measured to characterize the behavior of the spill and its surrounding environment in sufficient detail to provide all the data required to compare actual spill behavior with trajectory model forecasts."

Secondary objectives laid out in the operations plan were as follows:

—to observe the behavior of various types of oil over time, paying particular attention to spreading, lens ("pancake") formation, sinking, evaporation retardation, and tar-ball formation;

—to measure the chemical degradation of the oil over time;

—to define the processes involving oil in the surf zone;

—to document the appearance of the underside of oil pancakes by means of underwater photography.

Because of careful preparation by team members, the relatively easy accessibility of the Argo Merchant oil, and the strong logistics support provided by the Coast Guard, the team had by the end of the first full day of operations begun activities to accomplish all the planned objectives except the last; and that was accomplished shortly before Christmas. Looking at the scientific needs and at the capabilities being assembled in Hyannis, the team scientists decided to add two additional objectives to the list:

—to measure the distribution of oil in the water column; and

—to investigate the transfer of energy from waves to oil.

Biological and ecological research was also brought quickly into the operation, as scientists from WHOI, the University of Rhode Island, and the National Marine Fisheries Service undertook to determine the effects of the spill on plankton, fish, and sea birds in the area. The grounding occurred on Nantucket Shoals, one of the most heavily fished reefs in the region, and was sufficiently close to another—Georges Bank—to cause great concern by fishermen and scientists.

Fortunately, too, the Marine Mammal Commission met in Boston during the spill, and asked the team to provide a briefing. Elaine Chan did the briefing, mentioned that the team wanted a marine mammal observer, and invited the commission to send a representative. Shortly thereafter, Ben Baxter of the College of the Atlantic and his assistant, Barbara Morson, arrived to join the team for this purpose.

Accomplishment of the primary scientific objective—mapping the spill—was a coordinated effort involving visual sightings plus infrared and conventional photography. The principal source of the daily slick maps was Joseph Deaver of the USCG oceanographic unit. Videotapes and photos of the spill taken by Coast Guard and news representatives were also made available to the SOR team.

"Because of all this, mapping of the Argo Merchant spill was more extensive than that of any previous spill," said Grose.

Tracking the slick had not only a scientific purpose, but also a serious immediate use. Argo Merchant held together for more than a week, releasing oil at varying rates, until a heavy storm moved in. On Dec. 21 the ship broke in two and a huge amount of oil was discharged from the ruptured tanks. On Dec. 22 she broke again, triggering another massive release of oil.

At 4 p.m. on Christmas day Cdr. Charles Morgan, an oceanographer assigned to the Coast Guard's on-scene coordinator, called the team—whose numbers had dropped to five that day—to say that grave problems existed. He asked them to come over and look at the projected oil movements, which were based on then-existing currents and winds forecast by NWS. Team members hastened over and examined the projections, which showed that the spill could approach within two miles of Nantucket's beaches by Sunday afternoon, the day after Christmas. They compared the previous forecasts with the most recent map then being drawn by Deaver; the results were disheartening close.

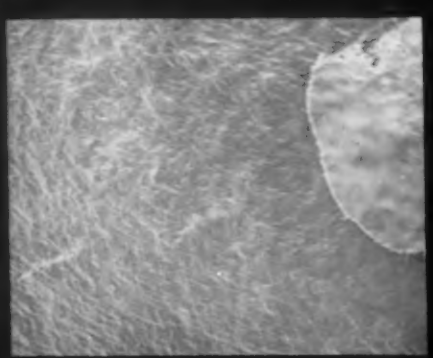
NOAA Photos by Baxter, Chan, Galt, Kennedy, Mattson, Paine.

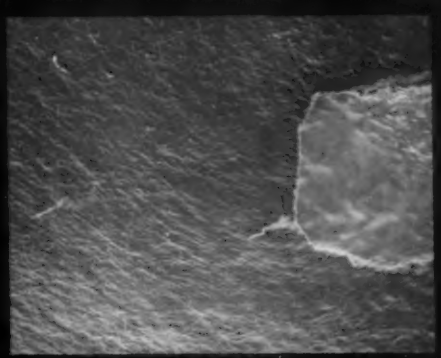
Under-oil photo by U.S. Navy for NOAA.

Argo Merchant, hard aground on Nantucket Shoals and leaking oil, as seen in NASA infra-red photo. Below, after she broke apart, the tanker is battered by storm waves as great masses of heavy fuel oil flow from her ruptured tanks.

Elaine Chan of EDS, first NOAA member of Spilled Oil Research team to arrive on the scene, leaves Coast Guard helicopter after surveillance flight over Argo Merchant oilslick.

Cape Cod and Nantucket beaches were threatened by heavy fuel oil from Argo Merchant disaster. At right, underside of oil "pancake" photographed by Navy Scuba diver; below, oil-smeared diver removes gear aboard Coast Guard Cutter.





Leading edge of the oil slick, as tracked by NOAA Spilled Oil Research team (right); small green die markers, floating with current, are overtaken by faster-moving slick, which is given extra push by wave action.

Of the seabirds affected by Argo Merchant oilspill, hardest hit appeared to be gulls, common to the area throughout the year. Below, Katherine Kidwell of EDS updates chart showing most recent location and extent of the spill.

Hasty conference of SOR team members (above left, l. to r.) Ronald Kolpack of University of Southern California, Sue Lease of ERL, James Mattson of EDL, precedes day's flights. "Hot lines" to NOAA and other installations to pass along most recent news are manned (above, l. to r.) by Richard Feely, PMEL, and Al Kegler of Alaska. Following flight, project manager Craig Hooper, ERL (seated, at telephone), is briefed by Jerry Galt, PMEL, while checking concurrent data with Coast Guard operational headquarters.

Far at sea, "Pancake One", largest oil mass located by the Spilled Oil Research team, is monitored from Coast Guard aircraft.

Dr. Peter Grose, EDS (left above), scans chart to check change in position of oil slick, while John Janssen (center) of Alaska's Department of Environmental Conservation assembles oil sampler on motel room floor. NOAA data buoy (left below), equipped for satellite tracking, is temporarily stored in motel stairwell. Samples (above) of the heavy industrial fuel oil from Argo Merchant had the consistency of cup grease.

What was needed was a large supply of drift cards, to be put in the water ahead of the leading edge of the slick, and notices to the public to be on the lookout for these cards. If the cards began to wash up anywhere on shore, the SOR team and the Coast Guard would know that the slick was close behind, and cleanup crews could be in place.

But the team had used up its supply of drift cards. So a telephone call was placed to Craig Hooper, back in Boulder spending Christmas with his family, telling him of the problem and asking that 20,000 cards—all that were available in Boulder—be shipped to the team right away.

Hooper worked all evening to locate a commercial flight that could get the drift cards to Boston; the Coast Guard had pledged that it would meet any commercial flight, and get the drift cards into the water. Finally he called to say that Continental Air Lines had just cancelled its 4 a.m. flight from Denver, the last hope, because of the weather. At his request Mattson and Lt. Cdr. Roger Cawley, who was responsible for coordinating beach cleanup, conferred. They decided that the cards were indeed badly needed; word was passed back to Hooper.

The night stretched on like a bad dream, with appalling weather and events appearing to conspire to frustrate the shipment while threatening the coast. At one point Hooper had to have a telephone call to Hyannis routed through London, as all domestic lines were hopelessly tied up.

He then left his family dinner, collected assistance from some of the Boulder staff of MESA (Marine Ecosystems Analysis group), drove to the county airport, and loaded a jet—chartered a short time before—with the cards.

At 5:30 a.m. the jet appeared over Otis, asking for permission to land. Once on the ground, the MESA people who had come along pitched in and helped unload the cargo. By 9 a.m. an HU-16 Albatross seaplane took off with the cards, which were deployed successfully between the then-menacing oil slick and the land.

The end of the story was anticlimactic but very welcome—the easterly winds never appeared, the slick moved away from shore, and the problem was resolved for the moment.

On the evening of Dec. 28, a group of SOR team members and Coast Guard officers who had dropped in—Capt. Hein, Cdr. Morgan, Lt. Cdr. Cawley—sat in the operations room relaxing, watching television, and talking about the situation. Among the ideas that came up was using Coast Guard marker buoys to track the oil, which the team would sometimes "lose" when bad weather forced cancellation of overflights.

Grose then suggested that what was really needed was satellite tracking through use of one of NOAA's small data buoys, a drifting buoy that he had helped develop while with the NOAA Data Buoy Office in Bay St. Louis, Miss. "Silence greeted his suggestion," recalled Mattson, "while we all sat there with the same reaction—'why didn't we think of that before'! "

So Grose called James Winchester, head of NDBO, at home. Winchester immediately set to work on the problem, and shortly found one of the buoys at Nova University in Florida, awaiting deployment. The University agreed to lend it to the project, and had it flown up.

On Dec. 31 the buoy was slung from a Coast Guard helicopter, which set out for the slick. Grose and Marilyn Pizzello, an SOR team member from PMEL, went out to deploy the buoy in the middle of "Pancake One", a huge oil lens, about 750 feet long and 450 feet wide, that had been spotted on Christmas day and tracked thereafter by visual sightings.

"The sun had set by the time we arrived at the area, so the Coast Guard used hover lights to locate the pancake," said Grose. "The helo hovered over the pancake at about 60 feet altitude, while we tried to release the buoy from the sling. Finally they cut the whole safety release mechanism away and the buoy dropped into place in the pancake. We arrived at Nantucket with only 30 minutes of fuel remaining, refueled, and got back to Hyannis at 9 p.m.—an unforgettable New Year's eve."

The buoy is a spar 10 feet long, with a flotation collar. Twice a day it sent a signal to NASA's Nimbus E satellite, from which NASA calculated the buoy's position and passed it along to the SOR team. This permitted them to track a part of the slick in all weather, and long after it was out of helicopter range.

Work in conjunction with the oil slick mapping was also of great value to the scientists working toward certain of the secondary objectives, including observing the behavior and characteristics of the oil pancakes and learning more about the underside of these huge masses of oil. Experience gained in an earlier spill in the Florida Keys showed that such pancakes can be up to six inches in thickness, and contain substantial amounts of oil. "Pancake One", for example, was estimated to contain about a half million gallons of oil, which in the cold water had roughly the consistency of cup grease or peanut butter.

On her second cruise, for example, Delaware II first covered, as control, an area of Georges Bank north of the spill and unaffected by it, then worked eastward, then down across an area that had been affected by the spill, and finally westward.

Nearshore studies began as early as Dec. 27, when MESA personnel assembled a team of biologists and chemists on Nantucket Island to develop a sampling plan for exposed beaches and inlets that would be vulnerable should the oil come ashore. The scientists—from WHOI, the Marine Biological Laboratory at Woods Hole, the University of Massachusetts, Northeastern University, and the Energy Resources Co.—obtained samples at four localities around the island. In addition, the U.S. Geological Survey obtained numerous intertidal samples which, like those collected by the MESA team, are in the custody of WHOI.

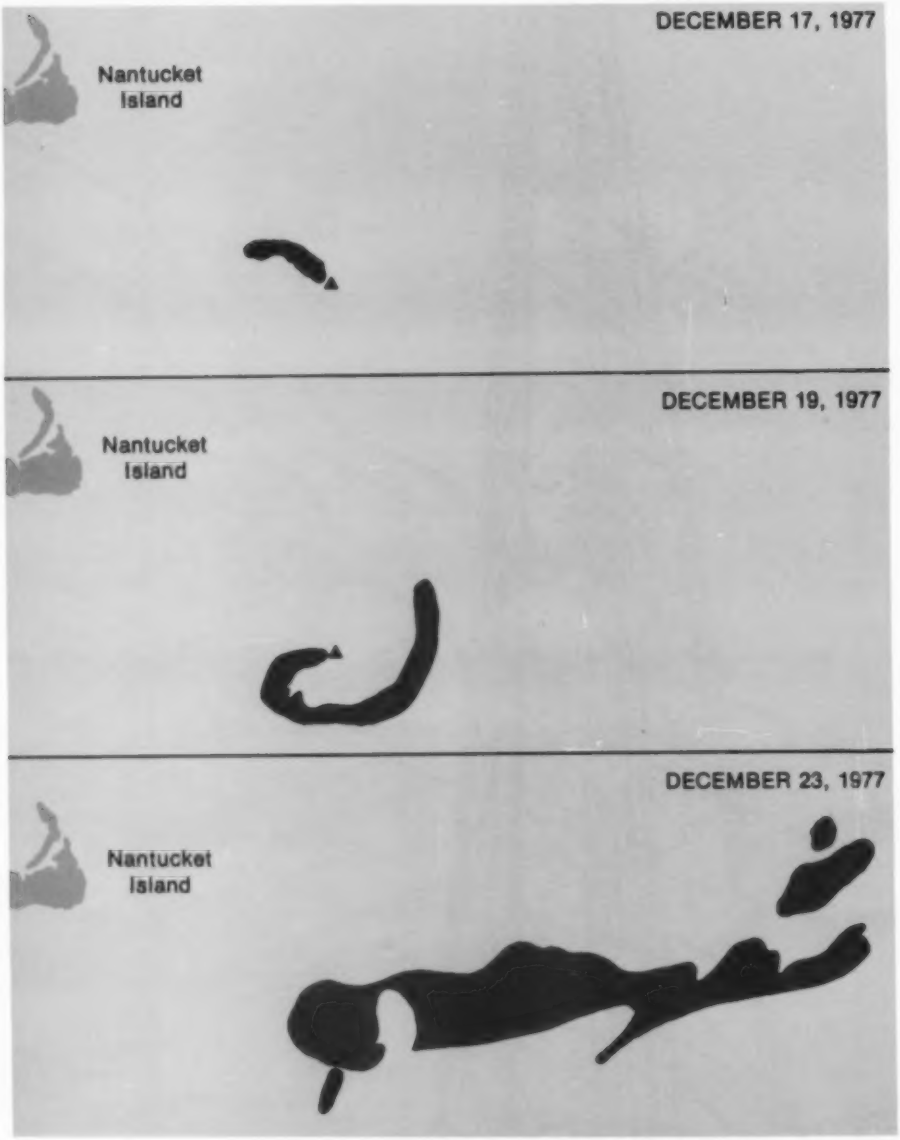
It was apparent to NOAA, two weeks after Argo Merchant went aground, that the SOR team had been highly successful in designing and organizing the research and modeling effort and enlisting the cooperation of organizations and individuals up and down the coast. It had also become apparent that in addition to the quick-response activities, a long-term assessment effort was going to be needed, because of NOAA's responsibilities under the Marine Protection, Research and Sanctuaries Act of 1972 (the "Ocean Dumping" Act). Dr. Robert M. White, NOAA Administrator, promptly directed that ERL, through its MESA program, lead and coordinate the NOAA effort at both short-term and long-term assessment of the impact of the spill on the ocean environment.

In his Dec. 29 memorandum, Dr. White provided for the initiation of a program of research on the long-term effects of the Argo Merchant oil on the ocean ecosystem, with particular reference to the fish stocks of the Georges Bank area. He also asked for an interim report. The SOR team immediately turned to, working over the following weekend and through New Year's Day, and by Monday, Jan. 3, had produced a detailed account of the cooperative research activities thus far undertaken.

Also on Jan. 3 and Jan. 4 a major meeting was held at Falmouth, with participation by 50 people from Federal and State agencies, universities, and research institutions, to analyze the results as then known of the scientific work, and to lay plans for a follow-up cruise in late January that might determine how much the Argo Merchant spill had contaminated the ocean bottom.

The comprehensive nature of scientific coverage of the Argo Merchant spill and the degree of detail that the SOR team was able to achieve is producing results that promise to be of great help in modeling future oil spills. The team found, for example, that it is not sufficient to use existing current tables combined with statistical models of winds as a basis for prediction of oil movement—winds and currents in the nearshore environment interact too closely for this to be adequate.

The following day was Christmas. The half



SOR team oil slick charts (here simplified) tracked daily oil movement, showing thick oil "finger" reaching toward Nantucket (Dec. 17), then curling around the grounded tanker (Dec. 19), and becoming more complex, with thick and thin patches to the east and a thick mass again pushing toward Nantucket (Dec. 23).

dozen SOR team members in Hyannis—Chan, Deaver, Lease, Mattson, Lou Butler of MESA/Boulder, and Alan Kegler of the State of Alaska Department of Environmental Conservation—took a little time in the morning to exchange Christmas gifts, around a small tree that they had put up in the operations room. A Coast Guard helicopter meanwhile retrieved the samples from the Vigilant. Then the team went back to work.

One of the important scientific objectives toward which the SOR team worked was to obtain a better understanding of the differing velocities of water and oil. While the oil moves with the water, it is given an extra push by wave action, and consequently moves more rapidly than the water. How much more rapidly depends upon a number of factors, including the size and speed of the waves. The team devoted several experiments to examining this problem.

One such experiment was undertaken by Galt and Mattson on Dec. 19. From a helicopter they released three dye markers in a line downwind and ahead of an oil pancake. This patch of oil was at the head of the 36-nautical-mile-long, horseshoe-shaped oil slick emanating from Argo Merchant. They used time-lapse photography to photograph the rate at which the oil mass advanced on the three dye markers.

The sequence of five photographs shows, for example, that at the beginning of the photography the oil was 42 feet from the nearest dye marker (which drifts with and at the same speed as the surface current). Slightly more than $3^1/_2$ minutes later the slick had advanced to within three feet of the dye marker. Using information from the photographs together with other data such as observations of wind speed and wave height from the nearby Vigilant, the team calculated differential water-oil velocity, surface current velocity, and other data needed for better modeling.

Major activities were also undertaken to find out what impact the oil spill would have on the biological populations of the area, both near the shore and in the waters and on the bottom at greater depths. In addition to biological work during the first cruise of WHOI's Oceanus II, biologists participated in two cruises of the NOAA research vessel Delaware II, a second cruise of Oceanus II, and a cruise of URI's Endeavor.

The first cruise of Delaware II took place Dec. 22–24, during which 11 stations were occupied, and the second Jan. 4–11, with 39 stations. Among the samples taken were surface plankton, skimmed off by use of Neuston nets; eggs and larvae in the top 50 meters of water, collected in Bongo nets; and bottom samples taken by Otter trawl. Fish samples were taken for hydrocarbon analysis, stomach analyses, and benthic (bottom) biological data. Biologists subsequently examined the eggs in laboratory analyses to get some clues as to the degree to which the oil spill might have adversely affected their development.

"It is difficult to sample near oil without contaminating the samples," said George Kelly, fisheries biologist at the NMFS Woods Hole laboratory. "During the cruises, we stayed well out of the oil slick initially, to collect useful baseline information, then went closer in."

Two days before Christmas a Navy diving team that had flown up from Norfolk, Va., was transferred to the USCGC Vigilant by helicopter, and members of the team dove into the chilly (41–43°F) water. They found the bottom, at 140 feet, to be clean white sand with no traces of oil but covered with clams, and they photographed a portion of it. They also took motion pictures and still photographs of the bottom of an oil pancake, which they found to be flat. The pancake was about an inch and a half to two inches thick; air bubbles from the divers would break through it, but it would then quickly coalesce.

Measurements of other pancakes from Coast Guard vessels, and during the New Year's eve buoy deployment, indicated that the pancakes were increasing in thickness as they drifted away from the ship, up to thicknesses of eight to twelve inches.

As a result of their dive through the oil, the divers lost three wet suits and most of their rubber gear, being unable to clean off the thick petroleum. They did succeed in cleaning their regulators and tanks. When they were brought aboard the Vigilant after the dive, with face masks caked with oil, they were led around the ship, and there was considerable concern about how to clean the oil off them. But one of the Coast Guardsmen brought up a container of shaving cream, which worked very well.

Two private contractors for the Bureau of Land Management's study of the New England Outer Continental Shelf also contacted the SOR team and helped with oil slick mapping. Aero-Marine Surveys, Inc., of

Quick-Response Research: Planning Paid Off

Early in November, in Santa Barbara, California, a new "real time" scientific research operation was born: rapid-response study of oil spills. A group of NOAA and Coast Guard oceanographers from opposite coasts of the United States came together to begin training sessions, developing and practicing the techniques for such an operation.

Before they met, there were no experts in such work. Only two of the group had been involved in oil spill studies. Dr. James Mattson remarked (to a company representative demonstrating a tool that they might use): "We're not just training, we're starting from scratch. We're training each other."

The Spilled Oil Research (SOR) teams grew out of NOAA's Outer Continental Shelf Environmental Assessment program, which is managed by the Environmental Research Laboratories for the Bureau of Land Management. One of the goals of that program is to develop mathematical models of oil spill behavior, to help assess the impact of oil leasing in the Gulf of Alaska. The NOAA/Coast Guard SOR teams, coordinated by Craig Hooper of ERL, will provide information obtained from actual spills that is necessary to develop viable models for forecasting the behavior of future spills.

Oil spill teams have been set up in four cities—Seattle, Juneau, Fairbanks, and Washington, D.C. Each team consists of three to six people from NOAA, the Coast Guard, State of Alaska, or University of Alaska. They must be ready to mobilize on a few hours' notice, rush to the scene of a spill, obtain a small aircraft and a boat, and begin their investigation.

The main purpose of the SOR teams is to measure the physical movement of various types of oil at sea under diverse oceanographic and meteorological conditions. They also hope to be able to observe how the oil behaves, and what chemical transformations it undergoes. Does it spread, sink, evaporate, or form tar balls? Other secondary goals are to define the processes that occur when oil enters the surf zone, and to measure the oil content of bottom sediments.

Each team is equipped with a kit containing equipment for making repeated measurements of currents, winds, waves, and the extent and path of the oil for at least 24 hours. An aluminum suitcase contains cameras, film, stopwatch, walkie-talkie, dictaphone, inflatable markers (and a compressed gas cartridge for inflating them), sextant, binoculars, and wind gauges. A trunk carries such tools as current probes, anemometers, thermometers, another camera, bags for collecting water and oil samples. Everything is ready for a call from the Coast Guard.

According to the plan that existed at the time of the Argo Merchant spill, whenever an oil spill of more than 1,000 barrels occurs the Coast Guard's National Response Center in Washington, D.C. would call Hooper or an alternate. The first individual contacted then calls whoever is in charge at the scene—usually the Federal On-Scene Coordinator—to learn more details about the size, accessibility, environmental conditions, and geography of the spill. The next calls are to Mattson, Elaine Chan, or Dr. Peter Grose, scientists with the Environmental Data Service in Washington; Gary Hufford, a Coast Guard officer and member of the Washington spill research team; and Dr. Jerry Galt of NOAA's Pacific Marine Environmental Laboratory, to discuss whether that particular spill is worth investigating.

The answer to that question hinges on the answers to a list of others: Is the spill large enough to be tracked for at least 24 hours after the team arrives? Is it a commonly transported type of oil or an odd case? Do the winds, waves, and currents of the area present an opportunity to fill a data gap? How easily and quickly can the site be reached? How difficult will it be to obtain the necessary platforms to conduct a study? Can the nearest team provide at least two members? Finally, is the spill or its environment unique in any way? Is a highly sensitive biological community threatened? Will oil enter a surf or ice zone where there are no data? Is there a large amount of suspended matter in the waters or an upwelling, which would be important to study?

If the decision is to go, the researchers will be on the way within a few hours. What they do when they arrive on the scene was carefully worked out in Santa Barbara.

There, the teams from Juneau, Fairbanks, Seattle, and Washington met with the Boulder headquarters crew to practice on the natural oil seeps in the Santa Barbara Channel. From a 25-foot cabin cruiser, some of the team members measured winds and temperature. Meanwhile, others circled above in a Cessna 182 to drop current and wind probes. The current probe, a two-foot tube of white plastic, sinks into the water, anchors itself to the bottom, and releases two colored plastic "rockets" at timed intervals. The rockets rise to the surface and release patches of green dye. By measuring the distance between the patches, the researchers on the boat can infer the distance that the first patch has traveled in the time between the releases, and, therefore, the speed of the currents.

The airborne and surface members of the teams keep in constant touch by walkie-talkie, and each observation and activity is recorded on a dictaphone. Photographs from the plane (a Cessna 182 was selected because its door can be removed for unobstructed views downward) reveal the area covered by the oil and record the positions of dye patches.

Such seemingly trivial problems as what kind of pattern the plane should fly had to be ironed out. An oval, or "racetrack" pattern was tried first. Then they settled on a figure-eight, making drops at the crossing of the "8," sweeping into a quick turn to come back and take photographs. The airborne members got to be good bombardiers, dropping current probes within 100 yards of the boat. Such accuracy was more than a nicety, for the observers on the boat must speed to the spot where a probe hits the water in order to time the appearance of the dye markers. It also helps to aim for the "downsun" side of the boat, so that the surface observers will not be looking into the sun.

Bright orange plastic drift cards dropped in the water track oil and current movements over longer distances. The cards carry messages printed in English, Spanish, and French, requesting the finder to notify NOAA of the location and time where they were found. These are dropped in batches of 25.

The teams worked long hours, testing over and over until a "run"—a complete runthrough of all necessary measurements—could be performed in an hour, and each member felt comfortable with the tools. At evening debriefing sessions they discussed problems encountered during the day, and suggested new approaches to try the next day.

What the oil spill researchers learned in Santa Barbara has since been put to rigorous test. Team members have gotten their feet oily on two major spills. Their techniques will doubtless continue to evolve. But one thing has changed already. Now the new type of research operation has experts.

New London, Conn., and EG&G of Waltham, Mass., sent personnel to Hyannis a few days after the tanker went aground. Aero-Marine Surveys brought in a twin-engine marine survey airplane, and used it to augment other slick mapping by making visual observations, dropping drift cards, and making surface water temperature measurements.

Measuring the distribution of oil in the water column, an objective added to the scientific work as the team began its operations, was carried on beginning with the first cruise of WHOI's ship Oceanus II. Numerous other cruises also undertook this work. In addition, Coast Guardsmen volunteered to take samples from their cutters from time to time, monitoring the slicks when no other ships were at sea.

"I took sterile bag samplers out to the Vigilant the day before Christmas," said Chan, "because that was the only ship on station then, and we wanted samples at that time. After the samplers were put aboard from the helicopter that flew me to the cutter, I was lowered in a personnel transfer basket. I had to go aboard to show them how to use the samplers. When I arrived on deck and took off my parka, the men on deck saw that I was a girl and gave a great cheer!"

Moreover, when real-time forecasting of oil slick movement is undertaken, the team found it highly necessary that there be both accurate maps of the existing slick and efficient transfer of data between models and observers.

Other essential contributions to better oil spill modeling include accurate measurements of oil-water differential velocities, observations that pancakes build up in thickness rather than disintegrate, and the results of the photography of the underside of an oil pancake.

Tracking and analysis of the movement and behavior of the oil pancakes also promise to be among the most useful results of the team's work. They tracked individual pancakes, originally up to two inches thick, that

Coast Guard and SOR team discuss just-completed seaplane flight over Argo Merchant. Joseph Deaver, Coast Guard oceanographer (left), sketches slick while aloft. Oil-smeared Navy scuba diver (below) provided valuable new information on the slick.

Photos: U.S. Navy

after a week or two of movement had become eight to twelve inches thick.

The team also found that these oil masses did not move as had previously been thought. A general rule of thumb—that they move at about three percent of wind speed—has been used in modeling and analysis. The SOR team found, however, that in this particular case the pancakes moved at only slightly more than one percent of wind speed, when the wind was 10 to 17 knots and oil thickness was more than one inch. In addition, the thinner oil sheens that cover much of the sea surface, probably "fed" by the thicker patches, also appear to be limited to the 1.1–1.2 percent "wind factor."

A NOAA C–130 aircraft from the Flight Operations Group in Miami went to Cape Cod for two overflights of the oil, on Jan. 12 and 14. Observers aboard the aircraft located numerous oil pancakes far out at sea, and sighted drift cards still accompanying them. They were also able to confirm that the data buoy was still floating in the vicinity of the oil slick, so the positions it had given twice a day continued to be useful for records of the oil's drift.

With respect to one of the concerns of some fishermen in the area—the amount of oil that may have sunk to the bottom—analyses as of the end of January showed no confirmed reports of oil, visible or otherwise, in any of the samples. This is consistent with the observations made by the Navy scuba divers, who one week after the grounding reported no visible oil on the bottom. Because the currents in their dive area are primarily tidal, oil had passed over the spot checked by the divers twice a day for the seven days.

A separate but related problem is under analysis by scientists of the National Marine Fisheries Service and of research institutions in the area. The fisheries biologists want to know the extent to which the floating oil may have affected fish eggs and larvae in the water, possibly posing a threat to future fish stocks. It is known that the oil will adversely affect the eggs and larvae that come in direct contact with it, but NMFS scientists are trying to determine if this actually happened to an extent great enough to affect commercial fishing in the area.

Of the bird populations, participants from the Manomet Bird Observatory found that herring and black-backed gulls, both common in the area, were the hardest hit by the spill. Badly oiled gulls landed on the Vigilant, and some accepted food by hand. Many birds in flight were seen to have oil patches on their underparts, and occasional dead birds were seen. Kittiwakes appeared to be less affected than gulls, and most gannets were clean. Fulmars, murres, and ducks were also affected, but bird observers reported that there appeared to be no massive effects on any of the species.

There was little early indication that marine mammals had been greatly affected. About six to eight finback whales, and two white-sided dolphins, were spotted by observers, and none indicated any adverse response to the oil.

"The real problem," said Ben Baxter of the College of the Atlantic, "is that if there were any animals in the oil that were affected, we probably will never know about it. If their bodies wash up on a beach and are reported, we may get a clue, but this is unlikely."

By January 9, 1977, the SOR team had essentially completed its on-site work, and members scattered to Boulder, Washington, Seattle, Fairbanks, and the many other localities whence they had come. A small monitoring team stayed on for another week, serving as transition for the MESA assessment effort that began to move in. The critically important 25 days that the SOR team worked on site thus became Phase 1 of the overall NOAA response to the Argo Merchant grounding, and MESA began Phase 2.

John Robinson of MESA established headquarters in Falmouth, and a group numbering about five, augmented by people from a variety of other organizations, began planning the next phase of NOAA's response. Early in January, it was agreed among representatives of the Coast Guard, EPA, BLM, and NOAA that NOAA would coordinate scientific work undertaken in Phase 2. Robinson is thus both the NOAA coordinator and head of the interagency coordinating team, which includes Dr. Paul Lefcourt of EPA, Robert Beauchamp of BLM, and Capt. Frederick Schubert of the Coast Guard.

Following up on Dr. White's directive, Robinson's group is carrying out the long term assessment, a task expected to last about 18 months. Work also continues within Phase 2 by NMFS scientists, investigating fin fish, shellfish, and ichthyoplankton, and by Woods Hole Oceanographic Institution scientists working on biological sample analysis. The long-term effects of the grounding of that tanker, however severe they may be, will be better known than has been possible for any previous spill. □

Photo: Roland Paine

Scarcely had NOAA staffers started writing their report on Phase 1 of the Argo Merchant oil spill when another hit Cape Cod waters. This time it was highly toxic No. 2 heating oil, flowing into the ice-choked estuary of Buzzards Bay and threatening thousands of dollars worth of nearby shellfish beds as well as large concentrations of diving ducks and Canada geese.

Because of NOAA's research interests in the behavior of oil in ice and its effects on fisheries resources,and because of the early estimate that more than 100,000 gallons of oil were spilled, personal plans were again shelved and NOAA scientists and back-up staff gathered in Falmouth to see how they might help.

The oil came from Bouchard No. 65, a tug-towed barge carrying its vital cargo to a fuel-short New England that was shivering through the worst winter in many years. The tug Frederick E. Bouchard had struggled for two days to cross Buzzards Bay, en route from Providence, R.I. to Portland, Me., by way of the Cape Cod canal. The tug was breaking a channel through the pack ice when the barge drifted onto a ledge at about 8:15 p.m. Friday, Jan. 28.

In a struggle to reduce the amount of oil spilled in the bay, the Coast Guard freed the barge from its mid-bay location and intentionally beached it 100 yards off frozen, windswept Wing's Neck, where another barge could be brought up and the oil taken off. Saturday morning brought relief when the barge Bouchard No. 85 was towed alongside and much of the cargo transferred.

Nearby Falmouth was the headquarters of the Marine Ecosystems Analysis (MESA) group charged with Phase 2—long-term assessment—of the Argo Merchant spill. The weekend barge accident found many of the group out of town, but on-scene consultants Ben Baxter and Barbara Morson made immediate plans for an overflight, while awaiting word as to NOAA's possible involvement.

On Saturday morning they made their first overflight, with the help and cooperation of Dr. George Woodwell of the Marine Biological Laboratory in Woods Hole. On Sunday evening ERL's John Robinson returned to coordinate the MESA effort on the new spill.

Because this spill took place within the waters of the state of Massachusetts, state and local officials were closely involved in the research as well as having responsibility for management of the area. George Kelly of NMFS' Northeast Fisheries Center at Woods Hole contacted state fisheries biologist Arnold Carr to offer assistance, while from the town of Bourne came Department of Natural Resources officers under the direction of Burke Limeburner, who hastened to collect shellfish samples before the beds could be fouled. Over the weekend Limeburner closed all shellfish beds as a precautionary measure, noting that "we may not know until spring if these beds are wiped out."

"The yellow (oil-stained) ice is bad enough at Wing's Neck," he continued, "but what concerns me is what is happening under the ice."

It was this concern that meshed the state and local effort with the MESA research activities. Robinson's group called in oil spill and ice pack experts from around the country to help. Dr. Seelye Martin and Peter Kauffman from the University of Washington sped to Cape Cod to lend their ice-pack research expertise to the problem, as did Paul Deslauriers of Arctec, Inc., a Columbia, Md., contractor with NOAA's Outer Continental Shelf Assessment Program (OCSEAP).

Meanwhile the transfer of oil to Bouchard No. 85 was completed Saturday night in temperatures approaching zero, and ice-breaking tugs took the two barges into Boston on Sunday morning, 24 hours after the Corps of Engineers closed the Cape Cod canal to all other traffic.

Dr. James Mattson and Elaine Chan of EDS joined the MESA people in Falmouth to lend their Argo Merchant quick-response experience to the effort. Garry Mayer, Kevin O'Donnell and Katie Baker of MESA, and George Heimerdinger—EDS liaison at Woods Hole—were among the others on scene.

What quickly became a cooperative interagency effort also saw Dr. Paul Lefcourt, Carl Eidam, and Peter Nolan of the Environmental Protection Agency, and Beth Hubbard of the Massachusetts Division of Marine Fisheries, working in cooperation with NOAA scientists.

Wednesday morning, Feb. 3, found some of the scientists fanning out on the ice to sample ice and water, while others set about locating supplies that would be needed for the cold and difficult work at hand. The Northeast Fisheries Center made equipment available, and the Coast Guard provided protective wet suits to enable the scientists to withstand the chilling winds on the ice. The U.S. Army's Cold Regions Research and Engineering Laboratory at Hanover, N.H., quickly lent ice corers and a portable viscometer.

The team located and purchased a chain saw with non-oil-lubricated cutting chain, so that ice could be cut for sampling without having lubricating oil foul the samples. A large heated van was rented and positioned on a spit of land near operations on the ice, to serve as field communications center and emergency aid station.

The first samples taken on the ice by Dr. Howard Sanders of the Woods Hole Oceanographic Institution were quickly analyzed with the help of WHOI's Dr. John Farrington, and the results made available to NOAA. From that sample analysis, the NOAA team and Burke Limeburner jointly planned succeeding sampling operations designed to provide the state and local officials with resource assessment information, and provide the NOAA team with research information.

The Coast Guard meanwhile continued its efforts to contain the oil, and remove it from the icy waters. Later estimates placed the amount spilled at about 80,000 gallons.

A week after the first oil-ice research began, the weather warmed and the ice started to melt. The research team completed much of its work, and the operation was throttled down. A report on the activities of the group was made to the selectmen of the town of Bourne on Feb. 9, and NOAA staffers from out of town dispersed to their many locations around the country. The permanent scientific staffs of the Marine Biological Laboratory and the Northeast Fisheries Center would continue their resource assessment work in conjunction with state and local officials.

Oilspills would never be commonplace, but valuable lessons were being learned about how NOAA could best react to them.

THE TOWER

By CARL A. POSEY

THE tower will rise 300 meters—nearly a thousand feet—from a section of farmland a few miles east of Erie, Colorado, a tiny town among several dotting the northern fringe of Denver's metropolitan area. From the freeways, the tower will have the vague, insubstantial look of open steel structures seen at a distance, rendered interesting to the eye by a flash of aircraft-warning lights that flicker like small lightnings at three levels on the structure. At night, the lights will automatically dim, to become an unusual constellation upon the brilliant Colorado night.

Stellar analogies are fitting here, for the tower will mark a watershed in a kind of environmental science that began in astronomy—remote sensing, the ability to make quantitative measurements from a distance.

Remote sensing. The term may be less than a household word, but the techniques it represents are pervasively familiar. The acoustical powers we admire in whales and bats are remote sensing. When Mr. Spock announces, "Our sensors show a nitrogen atmosphere similar to Earth's, Captain," he is talking remote sensing. Historically, remote sensing is how we have tried to comprehend the distant or inaccessible corners of the physical universe, fashioning telescopes to scan the heavens for objects the eyes cannot see, acoustic sounders to probe the light-devouring world of the sea, radio-frequency systems to read the invisible changes of the ionosphere.

Now a small band of remote-sensing people—specialists in wave and acoustic energetics, electronics, optics, and a host of other physics-based skills—are turning their techniques toward the more accessible, but still puzzling realm of the lower atmosphere. The tower will be a functional instrument enabling them to test their newly-developed remote sensors. It will also be a promise of accomplishments to come, for it is a centerpiece around which will evolve many of the atmospheric sensors of the next decades.

Today, with the high plains settling toward summer, the tower is beginning to take shape. Large concrete footings have been prepared at the Erie site. Massive prefabricated steel members have arrived at the site and are being assembled into 30-foot (10-meter) sections. Erection of the tower will start this month, and should be completed by August, 1977. Then it will be instrumented to read weather elements from the surface to the 300-meter summit, and remote-sensing operations will begin at the Boulder Atmospheric Observatory, or BAO, as it is called.

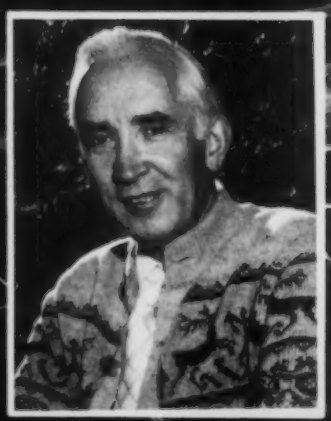
The BAO, to be operated cooperatively by the Wave Propagation Laboratory of NOAA's Environmental Research Laboratories and the National Center for Atmospheric Research, will seem to be mainly the tower. It has the characteristic triangular cross-section of such towers, but is heavier and stronger. It was designed to accept conditions even an apocalyptic combination of Colorado winds and winter weather can hand out—it will withstand a wind loading of 65 pounds per square foot, when sheathed in half an inch of ice.

Inside the tower skeleton a personnel elevator will crawl up a rack-and-pinion track, like a cog railroad climbing a vertical grade. An instrument carriage outside the tower will also ride on a rack and pinion drive.

As operations begin at the BAO, strange-looking electronic devices will begin to appear in the grassy section of land the facility occupies: optical radars and their cannon-esque telescope receivers, acoustic sounders that utter their signals in high-pitched beeps, radars of unparalleled sensitivity and ability, sensors that listen, sensors that see, sensors that probe with beams of light, or pulses of sound, or radio waves. At times, they have the look of swords beaten into plowshares—weather-sensing radars using surplused Nike-Hercules antenna dishes and trailers and miscellaneous tracking gear. Like many hybrids, they are unique.

The tower will be a vertical corridor of precise, continuous measurements from the ground to almost a thousand feet. The new sensors will be tested against the tower, and their evolution from their present hybrid form to the more polished systems industry can produce will be partly driven by how well they do in these comparisons.

Not all the sensors being tested at the BAO will look upward from the ground. The tower's column of accurate atmospheric measurements will also attract occasional visits by the versatile flying laboratories oper-



The Wave Propagation Laboratory's Dr. C. Gordon Little, who looks forward to using the Tower—or Boulder Atmospheric Observatory.

ated by NOAA, NCAR, and perhaps other universities and research institutions from around the country. For these, the BAO will provide the means of comparing in-flight measurements made during fly-bys past the upper reaches of the tower with measurements made by sensors on the tower.

As the BAO evolves, the tower will be joined by a 21,000-square-foot laboratory building constructed by NCAR, which is supported by the National Science Foundation. The NCAR building will house 30 to 40 permanent scientific personnel, and will complete the BAO's physical plant, providing the national facility anticipated by its enthusiastic proponents.

Chief among these, both in advocacy and enthusiasm, is NOAA's Dr. C. Gordon Little, who directs the Wave Propagation Laboratory in Boulder. To him, having the BAO up and operating will mark the end of one long trail—and the beginning of another.

"What the BAO gives us," he says, in a voice that still carries the sound of northern England, "is a well-instrumented cubic kilometer of atmosphere in which we can measure weather conditions down to a very fine scale of time and space.

"Our primary use of the facility will be to test and evaluate the new remote sensing instrumentation that appears to be at least part of the wave of the future in atmospheric research. Secondly, the BAO and its remote-sensing instrumentation will provide a unique site for studies of processes in the lower atmosphere that still have not been thoroughly observed—evaporation, precipitation, turbulence, diffusion, air-pollution chemistry, and the like.

"But we also see the facility as being an important national resource in the atmospheric sciences. We expect scientists from universities and other organizations to come to Colorado to participate in the kind of experiments we will be able to conduct only at this observatory. The interaction between atmospheric scientists and remote sensing specialists should be exceptionally strong, with many transfers of ideas and technologies occurring between the different disciplines."

With the BAO developing into a technical reality, its potential less than a year from being tapped, the solf-spoken NOAA scientist has focused his attention farther into the future, where he foresees exciting possibilities for improved weather services. For it is five, ten, fifteen years from now that he sees remote sensing in general, and remote sensing based at the BAO in particular, as having a major impact on the way we sense, analyze, report, and forecast local weather.

To understand this impact we have to look at how weather is observed today. Currently, the only three-dimensional views of weather are the periodic profiles written by radiosondes, the small balloonborne radio-equipped instrument payloads which sense temperature, humidity, and pressure, and which can be tracked to obtain wind measurements from the surface to about 100,000 feet (30 kilometers). These balloons are launched from stations perhaps 400 kilometers apart, twice a day, on a scale of time and space which meteorologists call "synoptic," a word that says we are comprehending a subject by viewing its principal parts in a general way. The technique works well for the global atmosphere, and for continental weather; it is also an important technical tradition in meteorology.

But the synoptic view inevitably fails to observe or predict the smaller-scale weather events that occur between these widely spaced observations.

This is a key problem in meteorology, and one on which progress comes very slowly. The reason for this slowness is the extreme difficulty of obtaining the large increase in weather data required to describe, understand, and predict small-scale weather phenomena. Using radiosonde spacing as an example, to take such profiles every 200 kilometers instead of every 400 requires a fourfold increase in the number of stations, and a twofold increase in the frequency of observation at each location. The difficulty lies in the eightfold factor. Then, because weather measurements are really measurements of *differences*, the accuracy of the measuring system must increase to detect smaller and smaller differences—again, a major problem. And then, with more measurements being taken more frequently, the time available to analyze the increased amount of data and shape it into a forecast is reduced, once more complicating things. Each significant descent to smaller scales of time and space carries something like a tenfold increase in complexity and cost. So progress is made, but it comes slowly.

Meteorologists now include the effect of the smaller scales by an averaging technique called "parameterization," which permits inclusion within synoptic scale predictions of smaller-scale events using key terms instead of full descriptions to represent those events. There is no substitute for parameterization in solving the massive problems of global and continental meteorology. But the technique inevitably averages out some atmospheric processes that are important down at the people-sized end of the weather spectrum.

For forecasters working the operational shifts of the world's meteorological services, the barrier in scale is a recurring nightmare. They are able to use the radiosonde observations taken 400 kilometers apart. But their interest goes down and down, to 200-kilometer spacing, to 100, 50, 25, 10, 5, and—in the case of airport weather—down to a kilometer or two.

"There are at least seven octaves [factors of two] in the spacing of current radiosonde networks and the needs of airport meteorology," says Dr. Little, whose excitement over the future of remote sensing and the BAO derives from his belief that his laboratory can do much to solve this problem of scale in meteorology.

"I think we offer a complementary approach," he explains by way of emphasizing he is not leading a revolution against synoptic meteorology or even presenting alternatives to it. "While meteorologists using conventional in-place sensors work the upper end of the scale, we will be exploring ways to measure the atmospheric *micro*scale, where we're dealing in terms of a kilometer or two and processes lasting a few minutes to an hour. This is where current ground-based remote sensors tend to do their best work."

Success in measuring microscale events remotely has been the major accomplishment of the Wave Propagation Laboratory, which, thus far in the 1970's, has taken an entire family of remote-sensing systems virtually from hypothesis to operating hardware. The laboratory has also begun to solve some of the difficult side-problems of applying remote-sensing technology to the atmosphere. Doppler radar, for example, has the unique ability to probe the interior wind fields of clouds. But to do this, it must operate at a data-acquisition rate that would blow fuses in today's operational weather-observing systems. Further, the technology of remote sensing as practiced in the Wave Propagation Laboratory presses hard upon the threshold of technical possibility—it is not merely advanced technology; it is *high* technology. It is to conventional weather instrumentation roughly what the *Concorde* is to the DC-3.

And yet—the time for a meteorological breakthrough of that magnitude may be at hand. The National Weather Service and the Environmental Research Laboratories are already discussing the Dopplerization of the new weather surveillance radars that are coming in to replace their less versatile predecessors at weather stations around the country. Weathercasters seem to look forward to using systems like AFOS (Automated Field Observing System) and AWANS (Aviation Weather and Notam System), both computerized handlers of massive quantities of weather data in tiny increments of time. These new systems are what meteorologists call four-dimensional, for they can move observations into the electronic pipeline any time, and are not constrained to the more traditional synoptic rhythms. Remote sensing has a place here. Witness the FAA technician in Atlanta talking about the experimental AWANS there: "This thing is great, but what it really needs is another way of getting data. I mean, we should have a bunch of remote sensors feeding the computer all the time. Then we could really get maximum use out of something like this."

Because of this growing emphasis on four-dimensional systems, one also sees synoptic rhythms begin to fade in projects like the Global Atmospheric Research Program's First Global Experiment. In that experimental year of intensive weather-data gathering over the earth's entire surface, there is emphasis on research-quality synoptic measurements—and parallel emphasis on what is called four-dimensional data assimilation, the fourth dimension being time. Remote sensors that work continuously or almost continuously, most of them aboard earth-orbiting satellites, have pointed up the fact that today's technology does not require everyone to take the same observation at the same instant over the planet's surface. Computers can work out such temporal details. Better, if technology can develop systems capable of handling such a torrent of weather data, to take data continuously and develop the ability to spin out reports and forecasts at any point in the flow of time.

Techniques like four-dimensional data assimilation are one way the synoptic meteorological system can force progress to smaller scales of weather. And at the moment, it is to the development of such techniques that much of the available meteorological support has had to go.

This means that while the world may make a path to your door for a better mousetrap, it will not for a better way of observing small-scale weather—not, at least, unless you help with the path-making.

Dr. Little understands that an experimental remote sensor operating in a Colorado wheatfield is not ready to be assimilated by the operational weather-observing apparatus. "We understand that the kind of technology our sensors require can be very difficult for your average technician to use," he says. "We also understand that our microscale data can be very hard to use operationally, at least as things stand today. Still, I believe we can develop systems through the BAO that will complement the synoptic observations, and perhaps relieve some of the pressure on conventional meteorological tools to operate at smaller and smaller scales".

The BAO will be the first step in a program aimed at meeting conventional meteorological observing techniques somewhere around what Dr. Little calls the "true mesoscale"—regions about 100 kilometers on a side.

"At the BAO," he says, "we'll begin by developing our abilities to observe and predict weather at what we're calling the airport and urban scales—roughly 10 kilometers and 100 kilometers on a side, respectively. The progression here would be first to perfect our ability to monitor, display, and describe the state of the atmosphere around us. Then, given this ability continuously to express the current state of local weather conditions over the area, we would work with the National Weather Service to help them use this capability in the preparation of improved short-term local forecasts. However, because our remotely sensed data exist on such a small area, we could forecast only for periods of an hour or two, though these detailed, short-term forecasts would, of course, be complemented by the standard, longer-range forecasts of the National Weather Service."

In three to five years he would expect NOAA could have a research prototype of such a system working at the BAO, making Denver's the best observed and forecast metropolitan atmosphere in the world.

The next step would be to the true mesoscale, where the earth's curvature makes it necessary to install arrays of remote sensors. Dr. Little sees another five years to prototype installations of this type.

"In some ways", he points out, "the forces that inhibit progress going from larger to smaller scales work for us when we go the other way. Notice that when you want to describe meteorological processes you need about the same number of data points, regardless of the size—you need about as many data points to describe a thunderstorm as you do to describe a hurricane.

"So if you begin, as we are, at the microscale, taking data of very high accuracy every second or two, and then go up to the larger scales, you find your life getting easier. The time available for your measurements expands instead of contracting. The phenomena you're measuring are larger and tend to last longer. You don't need the accuracies required at the airport scale. I don't want to say it's the difference between climbing up and walking down. But it *is* like first assaulting a rather difficult cliff, and then having an easier time walking on the plateau above."

In the conventional wisdom, the economics of remote sensing are viewed as an important part of that hypothetical cliff. Remote sensors of the type being developed by the Wave Propagation Laboratory are many times more costly than, for example, the tiny radiosonde transmitters and their balloons. On the other hand, remote sensors have a sensitivity and data rate that could fill a need that has gone unfilled thus far. "An airport is an expensive place, especially when you have an accident," Dr. Little notes. "I understand that the law suits associated with the Eastern Airlines crash at Kennedy Airport in June 1975 now total over $1 billion. I think our systems would be affordable at airports. At the urban scale—and urban implies something the size of Denver or Washington, D.C.—we have a lot of people who need a better view of local, short-term weather and air quality. I think we could be cost-effective there as well. At the mesoscale in densely populated regions we're talking about millions of people, and, again, it seems to me the arrays of remote sensors become affordable for that many consumers of weather information."

There is a kind of proof of affordability in the laboratory's experience: where a remote sensor has reached a point where it can be applied operationally, it has found an interested clientele.

Acoustic remote sensing is a case in point.

In 1969, Dr. Little told an interviewer that as his organization (then one of the Environmental Science Services Administration's Research Laboratories) moved into the remote sensing area they were exploring the possibilities of electromagnetic waves (radio, light, infrared)—and adding *acoustic* sensing to the picture. As development of this innovative acoustic approach went forward, according to Dr. Freeman Hall, who leads the laboratory's acoustic program and is directing BAO construction for NOAA, it soon began to draw interest from outside the government. "Back in 1972," Dr. Hall remembers, "we held a conference on acoustic sounders and what they could do. One of the attendees thought sounders looked like something his company might want to manufacture, and they began putting one out. Now they're the principal supplier of these units". About 150 of the sounders produced by private industry have been sold. In four smelting plants in the American northwest, acoustic sounders tell plant managers when atmospheric conditions are right for smelting—and when they are such that the plant should shut down, or modify operations. Highway departments are using acoustic sounders to determine whether new routes will encounter persistent, pollution-concentrating atmospheric conditions. Lumber mills use acoustic sounders to determine when slash burning will not cause low-level air pollution. "It's a very good example of technology transfer", says Dr. Hall.

Technology transfer determines where remote sensors go when they grow up.

Another family of acoustic sensors—a Doppler acoustic sounding system that can detect velocities and altitudes of wind shear above an airport—was developed by the laboratory with support from the Federal Aviation Administration. It is a large system, requiring great horn-shaped listening antennas in buried bunkers, a minicomputer, and other expensive gear, and for a while there was some question as to how important real-time wind shear information really was to aviation.

Then the 1975 crash at New York's John F. Kennedy International Airport made wind shear, always a familiar hazard to pilots, an aviation hazard everyone knew something about. Another jetliner crash at Denver's Stapleton International later in the year reinforced the point. The acoustic wind shear detector became more than an interesting technical development—it became a way to save lives and property at an airport. That technology, along with some other remote sensing techniques from Boulder, is now in the process of transferring to the world of aviation safety.

"The fact is," Dr. Little explains, "at this time we have more other-agency support than NOAA support for these devices. I think part of this at least comes from our former Central Radio Propagation Laboratory connection. (The Central Radio Propagation Laboratory, which Dr. Little directed, was one of three major elements combined in 1965 to form NOAA's predecessor agency, the Environmental Science Services Administration). While the CRPL background enabled us to bring new remote-sensing talent and experience into meteorology, it worked the other way too. We're also viewed as meteorological *arrivistes*; we don't really speak the language, and it's difficult to bridge between what we do and the operational world of meteorology. But if NOAA is to make maximum progress toward weather reporting and prediction at these small scales, it is absolutely essential that we develop a joint Wave Propagation Laboratory—National Weather Service program to exploit the advantages of remote sensing for the monitoring and forecasting of local weather conditions.

It may be that people think of remote sensing as a new concept, but it isn't at all. I began in radio astronomy, he explains, referring to his graduate days at the University of Manchester, "which is *really* remote sensing. Then I went to remote sensing of the upper atmosphere and ionosphere, which we sensed remotely because we couldn't get there to measure things in place. Now we're in a more accessible part of the environment, not because remote sensing is the only way to measure events there, but because it permits us to measure events there extremely well."

For the coming decade, his laboratory's remote sensors will be doing what they do so well at the Boulder Atmospheric Observatory near Erie, so that those twenty-first century weathermen will have the kind of tools they'll need to do the kind of jobs they'll have to do. □

V-I-C-T-O-R-Y!

That one word, emblazoned in type two inches tall across the front page of the Minot Daily News the day after Easter, 1976, said it all for the 35,000 citizens of that North Dakota community last spring.

As the rest of the nation looked on, a volunteer army of plainsmen had fought and won a week-long battle against a usually placid river turned roaring torrent, because an unusually fast and furious spring thaw had sent enormous quantities of icy water cascading down from Canada into the Souris River, which passes through the heart of Minot.

There had been a clear danger that a 35-mile-long system of earthen dikes thrown up by the U.S. Army Corps of Engineers would be breached, unless volunteers pitched in with sandbags during the last few hours before the crest. A rainfall that approached two inches in 24 hours literally precipitated the crisis. So it was not surprising that the Minot Daily News saluted the victory in emotional prose when the crest had passed. Excerpts:

"Their city called and the people of Minot came out, the young and strong . . ., the not-so-young but determined. . . . They put their hands and their bodies against the rising menace of the Souris River . . . . They answered the call for sandbaggers. . . . They stopped the river on a Saturday afternoon. . . . (They) worked and sweated in a cold rain, putting bags on tops of dikes only six inches from a rising river . . . And a town was saved."

A major part of the victory was credited to the Army Engineers, under the direction of James Ruyak, who supervised construction of the dikes protecting the endangered city. Mayor Chester Reiten said no words could express the gratitude of the townspeople for his leadership.

Forecasters of the National Weather Service also received special praise for the accurate predictions of the river's crest that made it possible for flood fighters to anticipate the peak stage of 56.08 feet—more than seven feet above flood stage—that occurred in the predawn hours of Easter, April 18. Herman F. Mondschein, Hydrologist in Charge of the Kansas City River Forecast Center, received the 1976 NOAA Public Service Award "for very early high-quality Souris River Basin spring-snowmelt advisories prior to the melt period, and for his timely and accurate . . . daily forecasts" during the flood emergency. Also cited in separate commendations by Commerce Secretary Elliot L. Richardson and Weather Service Director George P. Cressman were other members of the staff at Kansas City, and the staff of the Weather Service Forecast Office at Bismarck, N.D., under Meteorologist in Charge Ellis Burton.

The inspiring story of

THE BATTLE OF MINOT

BY EDWIN P. WEIGEL

On hillside above Minot, earth-moving equipment rumbled night and day scooping up vast quantities of earth for completion of 35 miles of dykes to protect 4,000 homes.

Minot Daily News

The Bismarck Forecast Office was responsible for gathering many of the rainfall, snowfall and river-stage measurements which were sent to Kansas City for production of the computerized forecasts for the Souris River. It also was responsible for delivering those forecasts to the people of Minot and elsewhere along the River. During the critical last days, Bismarck meteorologist/hydrologist Robert Barnicle was dispatched to Minot. There, he maintained a grueling schedule of thrice-daily television broadcasts to the Minot citizenry—at 7 a.m., noon and 10 p.m.—from April 12 through 19 at the Minot Flood Control Center. The broadcasts were coordinated by Mayor Reiten and usually included Barnicle as lead-off man, giving the latest weather and river observations and forecasts, followed by a status report on the dikes from Army Engineer Ruyak, and public-safety information from city and county officials.

Four days before the crest arrived on Easter morning, between 12,000 and 13,000 persons were evacuated from the flood plain in Minot, and the area was sealed off by a cordon of National Guardsmen, policemen and firemen. Emergency housing was provided for evacuees by the Red Cross, Salvation Army, the U.S. Department of Housing and Urban Development, and a variety of other public and private organizations and individuals.

It was no accident that Minot was able to conduct a well-organized and successful battle against the 1976 flood threat. Six times during the previous seven years, the Souris River (Souris means mouse, in French) had been swollen by spring snowmelts above the flood stage of 49 feet at Minot's Broadway Bridge. During four of those years the river rose four or more feet above the level of the flood plain. The highest levels were reached in 1969, when there were no dikes and the river rose 6½ feet over its banks to flood homes of 12,000 people, causing 7 million dollars in damages, and 1976, when the river rose 7 feet above flood stage but was contained by a 3-million-dollar system of dikes built by the Army Engineers.

Here is how it was in 1969, in this description adapted from an article in the Minot Daily News.

Easter came early that year, on April 6. It arrived in brilliant sunshine—a perfect day, heralding the end of another tough winter. But snow still left on the ground began to melt at a furious pace. Soon the Des Lacs River, which feeds into the Souris above Minot, became a raging torrent. Before most people could begin to comprehend what was happening, Minot's fate was sealed. The next day, the first Minot home was abandoned. The day after, on April 8, eighteen more were emptied. By April 10, as water flowed through the streets, 300 families had left. Then came information that the Des Lacs was just a starter, that Minot faced an even worse deluge from the Souris. Some didn't believe it, but the information was tragically correct. On April 17, what was until then the greatest mass evacuation in North Dakota took place, as upwards of 12,000 more people moved out. The Souris flowed in, overwhelmed an almost defenseless city, and submerged almost half of Minot under muddy waters, covering many homes halfway up the first floor. Not until the end of May were many of the 12,000 able to return and view the sickening damage.

The fact that the results were so different last spring, in spite of an even greater flood threat, is a story of great complexity involving a host of agencies and people, all focused on a common concern: the provision of early warnings of possible flood danger, followed by appropriate actions for the savings of life and property, and the reduction of hardship.

The Souris River rises in Canada in Saskatchewan, loops south and eastward through north-central North Dakota, and flows north again into the Canadian province of Manitoba. Thus Canada and the United States join forces in gathering data on possible flood threats and issuing flood warnings for the Souris Basin. There is continuing and active exchange of information. The river drains a basin of about 25,000 square miles and is about 730 miles long, with about half of this in Canada and half in the U.S.

Minot is the major city in the basin, and is surrounded by rolling wheat fields. It is primarily a farm trading center, the fourth largest

Dykes funneled Souris River into a narrow channel at point on the outskirts of Minot, above, thus protecting downstream homes and businesses on either side, in the heart of the city.

Heavy rain on the day before the flood crest brought small army of volunteers to save the dykes from erosion with snow fencing and to add the last tier of sandbags needed to contain the Souris. Water came within inches of topping dykes.

Photos: Minot Daily News

James Ruyack of Army Engineers, above, was credited with saving the town by skillful management of dyke-building before and during the crisis. Working from Flood Emergency Center, he was in constant touch with dyke construction and repair crews. Weather Service's Robert Barnicle, at left in adjacent photo, delivered vital forecasts to Engineers.

Photos: Edwin P. Weigel

city in North Dakota. It is served by two railroads, the Soo Line and the Burlington Northern, and has a jetport served by North Central and Frontier airlines. An important neighbor is the Minot Air Force Base, twelve miles north of town, home for 7,000 military personnel and 13,000 dependents. It is also home for the 91st Strategic Missile Wing (Minuteman missiles), the Strategic Air Command's 5th Bombardment Wing (Boeing B-52 Stratofortresses and KC-135 Stratotankers), and the 5th Fighter-Interceptor Squadron (Convair F-106 Delta Darts). The Strategic Missile Wing is responsible for 150 Minuteman III missiles in underground silos within 75 miles of the base. Thus this base is one of the strongholds of U.S. deterrent power against nuclear attack.

The process of preparing each year for the best prediction possible of what the Souris will do in the spring begins in autumn with rainfall observations by weather observers scattered throughout the Souris watershed. In Canada, these observers are Government employees. In the U.S., most are cooperative observers. They keep track of rainfall, river stages and, after the winter has set in, of snow depth, on a periodic basis. U.S. observers relay this to the River Forecast Center in Kansas City, Mo., where it is stored for later preparation of computerized forecasts, and Canadian observers send theirs to a comparable center in Canada.

Barnicle said autumn observations preceding the flood indicated twice-normal precipitation in the Souris Basin from August through September. He added that when the ground froze a week or so later, it "was really saturated"—far more than normal. By early February, Weather Service hydrologists were already anticipating a major flood on the Souris, because, in addition to the record-wet autumn, above-normal snowfall was occurring. Biweekly flood outlooks were issued from February through March. An outlook issued March 25 called for a maximum stage of 5 feet above flood stage in Minot in late April, equal to the second-highest level of record.

In late March, gamma-radiation flights were made by a specially instrumented aircraft over the Souris Basin, in cooperation with the Canadian Government, to measure by electronic means the water equivalent of the snowpack over the Basin. These confirmed ground reports of up to seven inches of water in the Canadian portion.

Because of the seriousness of the situation, Dr. Robert Clark, Director of Hydrology for the Weather Service, briefed North Dakota Congressman Mark Andrews and Minot Mayor Chester Reiten on the growing threat.

On April 8, the forecast was revised upward because of unusually rapid melting of snow in some portions of the Souris Basin in Canada, starkly revealed by a succession of NOAA satellite photos. The new forecast called for a crest of 56 to 57 feet in Minot occurring on April 21. This would exceed the 1969 (highest of record) crest of 55.4 feet by a foot or more, with the river rising to between seven and eight feet above flood stage. Charles Knudsen, Director of the Weather Service's Central Region, visited Minot on this date and briefed city officials on the implications of the revised forecast.

Meanwhile, the Army Engineers were continuously kept abreast of the changing outlook and were increasing the height of the dikes. After the 1969 flooding, earthen dikes had been constructed along the Souris where it passed through Minot to prevent a similar occurrence. Tops of the dikes then were placed at 57 to 58 feet, which meant the new 1976 forecast was at or near a spillover level. The pace of dike-building and channel improvements quickened.

On April 12, Barnicle arrived at the Minot Flood Control Center for a week-long vigil. His job was to relay to the city the river observations and forecasts from the River Forecast Center at Kansas City, Mo., and from Bismarck.

Also, at about this time, other key officials and agencies at every level—local, state and federal—began to meld their activities to produce a united front against the flood threat.

Undoubtedly the best chronicler of these efforts, large and small, was the Minot Daily News. What follows are selections from that newspaper's accounts of the events of April 12 through 19.

Dateline Monday, April 12—Water came over the spillway at Lake Darling above Minot on the Souris for the first time, at 7:40 p.m. Sunday. Two cranes were used to break up the edge of a mass of ice 200 acres in size, to start the flow. U.S. Fish and Wildlife Service officials, in charge of the dam and the Upper Souris National Wildlife Refuge, said the dam was in excellent shape.

That same night, about 300 large dump trucks were roaring through the streets of Minot, rushing to provide dirt for completion of primary and secondary dikes, and ring dikes around schools in the flood plain.

The Soo Line Railroad was preparing to elevate a bridge to

Kansas City River Forecast Center, left, was responsible for highly accurate forecast of Souris flood crest. Hydrologist-in-charge Herman Mondschein, standing, was awarded Commerce Silver Medal for his role. Weather Service Central Region Director Charles Knudsen, above, coordinated Weather Service input.

keep it from impeding the flow of water through the city. Burlington Northern was ripping out a bridge near an overpass.

The Weather Service was predicting a crest in Minot 8 feet above flood stage.

Mayor Reiten reported on TV that should a dike break or the river overwhelm the dikes so the entire system gave way, there could be as much as 14 feet of water in the Minot flood plain in one area, 8 to 10 feet in others, and a minimum of 6 feet in evacuation zones.

Evacuation of the flood plain was slated for Thursday, April 15 (it was subsequently advanced to Wednesday). Already, most residents in designated flood zones were packing belongings or moving them to second stories, obtaining trucks, and hauling away as much as possible. A few said, "To hell with it," and walked away leaving belongings where they were, saying they were tired of the annual nightmare.

City officials announced that there would be a "sweep" through the city at the 8 p.m. evacuation deadline by uniformed officials to see that everyone was out. After that, areas were to be considered sealed, and nobody let in without special permission.

Flood-insurance officials told evacuees that a "reasonable effort" had to be made to protect contents of homes. Evacuees were also told losses would be paid for on an "actual cash value basis," that is, replacement costs minus depreciation. Flood-insurance policies were to cover direct losses to buildings and contents from flood waters, hydrostatic pressure, sewer backups and seepage.

North Dakota Governor Arthur Link asked President Ford to declare north-central North Dakota a "disaster emergency" area, which would make it eligible for Federal assistance in coping with the flood and housing evacuees. The Governor said emergency housing was a critical problem, and that in Minot alone, some 12,000 people needed emergency quarters. Mayor Reiten said an official of the Federal Disaster Assistance Administration of the Department of Housing and Urban Development was expected to arrive that afternoon to discuss a city request for temporary trailer homes.

The U.S. Coast Guard announced it was to arrive in Minot from Dubuque, Ia., with six small boats to assist in flood rescues, if needed.

A National Weather Service cooperative observer at Sherwood, N.D., where the Souris River enters the state from Canada, reported that flood waters had begun to recede from the four-inch level they had reached Friday below the first floor of his farm home near the riverbank. Observer Elmer Harkness said he and his wife had been forced out by the flood. He said the water level was eight inches lower than the 1904 flood. Harkness said that he now planned to move his home, only 80 feet from the river, west to the hills.

Tuesday, April 13—The Weather Service advanced the predicted date of the flood crest from Wednesday, April 21, to Saturday, April 17. Forecasters still were predicting a crest as much as 8 feet above flood stage.

The evacuation deadline was moved up from 8 p.m. Thursday to the same time Wednesday because of the change in flood-crest prediction. A total of 13,000 evacuees was now predicted. Gas was shut off in three of the nine evacuation zones. City Manager John Arnold said the advancement in evacuation of 4,200 homes was part of the original plan, because it had always been slated to take place three days before the crest. "It is during the rise to the crest that dikes can wear away," he said.

Stage reading at Broadway Bridge was 51 feet, two feet above flood stage.

Ruyak, leading the Corps of Engineers effort, said an "army" of people would be needed to complete the roughly 35 miles of diking at a safe level. He said his aim was to have dikes high enough to handle a flow of 11,000 cubic feet per second with two feet of freeboard, because the Weather Service was now predicting a flow of 10,000 to 11,000 cubic feet per second, considerably more than occurred during the floods of 1969 and 1975. Ruyak advanced his goal for completion of diking from Friday night to Thursday night.

Nearly 270 persons from the Minot Air Force Base and Minot Radar Station were helping with evacuation, with some 30 trucks and vans from the base. Farm families volunteered their trucks. About 12 to 15 percent of the evacuees were requesting transport aid. About 50 women volunteered to handle phone calls at flood-control and evacuation centers. All 60 members of the Pioneer Citizens Band Radio Club were helping. About 380 people were filling sandbags, from three Minot high schools, Boy Scout troops, the Mennonite Disaster Service, the Civil Air Patrol, and the Northwest Bible College. About 25 auxiliary police members were assisting the Minot Police Department and the Ward County Seriff's Department with traffic control.

Wednesday, April 14 (departure day)—The Souris was rushing through the city at a rate of 6,200 cubic feet per second, already exceeding the 1975 flow rate of 5,700 cubic feet per second. Engineer Ruyak said this flow would produce continuous erosion of the dikes, and "we will have to rebuild the dikes constantly." He said a foot of earth was being added to primary dikes in the western part of the city, and that four contractors with earth-moving equipment were on standby during the flood-crest emergency, two on each side of the river.

Gas supplies were being cut in more homes. Electricity remained operative to provide power for emergency equipment. The Northern States Power Company said, however, that switches could be thrown to shut off power in a matter of minutes should dikes break.

Departure day for Minot evacuees was cloudy, cold and windy, although there was no rain. Other parts of North Dakota got heavy showers and thunderstorms.

City Manager Arnold told residents that the evacuation deadline "must be met." He said that at 8 p.m. policemen, auxiliary police, firemen and National Guardsmen would begin checking houses to see if they were empty.

Arnold clarified the city order requiring evacuation. He said it was mandatory, that some residents had mistakenly assumed their signing of a form stating how many people were in the residence was a waiver of the evacuation order. Not so, he said.

Three animals at Minot's Roosevelt Park Zoo died after being tranquilized for removal to other quarters—a bear, a white-tailed deer and a wolf.

Reports of price gouging for emergency housing and other flood emergency activities were received by the North Dakota Attorney General and Ward County States Attorney from some Minot residents. The state officials mentioned arbitrary raising of rents when emergency housing was sought and the requiring of long-term leases. They said there might be "prosecution to protect the citizens" and advised evacuees to deal only with established firms known to be reliable.

Internal Revenue Service District Director Mitchell Premis announced from Fargo that people and businesses in the flood-plain area—already given a month's grace on state income taxes—would be granted a reprieve on federal income taxes also.

The Verendrye Electric Cooperative, Inc., said electrical equipment inundated by flood waters is extremely dangerous, and that electric service must be disconnected in areas where flood waters reach service entrance boxes and other facilities. Basements filled with flood waters are particularly hazardous, the Co-op said. Flood-plain residents were asked to call for discontinuation of service, and were told the Co-op would provide free inspection after the flood to make sure resumption of service was safe.

The Red Cross flood-refugee center at Jim Hill Junior High School Center said it was prepared to house 200 evacuees. By nightfall Tuesday, 647 persons had applied for emergency housing at the Minot Area Information and Referral Center. The Center's Director said progress was being made and that many of the evacuees were already settled in and around Minot. The Red Cross said about 60 people were in the school shelter on Tuesday. He said most persons needing shelter would go to friends, relatives, or a hotel or motel before coming to the shelter. He said the shelter at the junior high school was manned 24 hours a day by volunteers. Cots were set side by side without partitions. About 35 volunteers were working there, in shifts. The Red Cross was providing three meals a day to people in the shelter and also sending vans with hot food on a regular circuit to feed workers in the flood plain. A registered nurse was on duty in the shelter 24 hours a day. Minot's Trinity hospital had made 20 beds available and some displaced persons had moved in there. City officials said more emergency housing was needed desperately.

By nightfall, almost 4,000 homes in the flood plain stood empty.

Thursday, April 15—The river stage at Broadway Bridge topped 54 feet, more than five feet above flood stage, according to the Weather Service's Robert Barnicle. He predicted rain and thunderstorms for this day and the day following.

Engineer Ruyack said this could cause serious problems for dike workers. "Anytime you get delayed it's serious, and the rain could do just that, making the dikes muddy and slippery. I'm not looking forward to it."

City manager Arnold reported that most houses in the evacuation area were empty, with lights out and doors locked when 85 National Guardsmen, firemen and uniformed police made a "sweep" of the flood plain in Minot Wednesday night, but that despite the city council's mandatory evacuation order, 80 persons in 33 households chose to stay in their homes. He said that people who refused to leave were asked to sign location forms in case dikes broke. Coast Guard rescue units were told of their locations. For the time being, city officials were told not to force people from their homes.

On Thursday, evacuees were permitted to return to their homes for brief periods after showing a driver's license for identification at checkpoints. They were asked to leave by the same checkpoint they entered. Security was tightened to prevent looting and vandalism. Even so, there were isolated instances of theft.

Arnold told people in temporary quarters in mobile homes that garbage service would be provided for them by the city. He said drinking water was considered safe for all of Minot, with part of the supply coming from wells.

Around noon, rain began to fall, ending a very long dry spell in Minot, and Barnicle forecast the rain to continue for at least 24 hours. The flood crest at Minot was now predicted for Saturday at 56½ feet, or 7½ feet over flood stage.

Water pressure collapsed basement floors of two houses outside the dikes, necessitating construction of "ring dikes" around them to contain the water.

Frantic calls were received the night before by city officials from a woman living west of the golf course. Speaking tearfully in broken English, she said her home was surrounded by rising water and that she was worried not for herself but for her animals—12 sheep, eight lambs and one horse. She said she would not leave until assured they would be rescued. Sheriff's deputies were unable to respond in the darkness, but at dawn evacuated the 62-year-old woman and her daughter, and later rescued her livestock.

The Minot city council unanimously approved a resolution allowing for "arrest and imprisonment" of anyone staying in their homes in the flood plain without permission from the city. The Council also reported completion of plans for dike patrols, so that aldermen from each ward were responsible for one area. Dike walkers' walkie-talkie radios were set to Citizens' Band Channel 11, and officials asked other radio operators to stay off that channel. City Council President Edward Schmit said mobile bases would be provided where dike walkers could get lifejackets, flashlights, batteries, coffee and food. He said shifts would usually be three to five hours long.

Minot's civic auditorium, usually the scene of basketball games, rodeos and variety shows, had become a giant furniture warehouse, the storage place for belongings of displaced persons. Airmen from the Minot Air Force Base were helping to move the furniture into the auditorium.

Good Friday, April 16—The Daily News headlined this "prayer day." The Weather Service's Barnicle said Minot was "definitely going to get rain late this morning or early this afternoon. He said it might total as much as 1½ inches or more. He was right. Rain developed about noon and spread over the Souris Basin. The Weather Service said it was a "major storm" that could last up to 36 hours and possibly result in two inches of rainfall. They said it also might change the timing of the flood crest at Minot, which earlier had been predicted for Saturday at 56½ feet at Broadway Bridge. The main concern, forecasters said, was strong winds expected to

Photos: Minot Daily News

Photo: Edwin P. Weigel

Thrice-daily weather and river forecasts were issued by Weather Service meteorologist Robert Barnicle, left, at television broadcasts conducted by Minot Mayor Chester Reiten. Warnings gave 12,000 residents ample time to evacuate before flood crest.

sweep across Lake Darling upstream and increase the flow into Minot.

At noon, the Souris was rising steadily, reaching 54.8 feet at noon, with an unprecedented flow of 8,300 cubic feet per second.

Ruyack, the unflappable Army Engineer, said, "I still haven't seen anything we can't handle." Others commented that all of Ruyack's skills had gone into the strengthening of the 35 miles of dikes, with 750,000 tons of dirt.

City Manager Arnold said only one family now remained in the evacuation area, where the day before there had been 33. He said an alderman was to call on the holdout, and that if voluntary acquiescence was not achieved, "we might have to consider other measures."

President Ford declared the Minot flood region a "major disaster area," according to notifications given to North Dakota members of Congress. Among other aid, this meant the Small Business Administration would move in with low-interest loans to stricken businesses and individuals, and disaster unemployment compensation would be available for persons temporarily thrown out of work.

Asked to comment on how much the flood battle had cost this year, City Manager Arnold gave a "shotgun" guess of 3½ million dollars for the elaborate dike network, plus city costs and damages of 1 million dollars more.

Officials estimated that well over half of the evacuated homes were covered by flood insurance, amounting to more than 2,500 policies worth 40 million dollars in coverage.

The Salvation Army was serving 2,000 meals per day, around the clock, and was offering free food and clothing to anyone affected by the flood.

Upstream at Lake Darling, the Bechtold Excavating Company of Minot, and service equipment of the U.S. Fish and Wildlife Service were completing work on placing riprap (a layer of rocks) at the top edge of the upstream face of the earthen dam, to protect it against wave action. Earlier Donald Steward, regional hydrologist with the Fish and Wildlife Service, had closed one gate in the dam by 3½ feet at the request of Army Engineer Ruyack, to reduce the flow somewhat into the Souris River. Flows were measured at 4,254 cubic feet per second through the gates and 3,145 cubic feet per second over the spillway for a total of about 7,400 cubic feet per second, a drop of about 600 from the preceding day.

In Minot, under the direction of Arnold, crews pumped rainwater out of the flood plain through Friday night. The storm-sewer system, which ordinarily drains into the river, had been cut to prevent the river from backing up into the town beneath the dikes, so it was necessary to pump rainwater over the dikes into the river.

Steady rain Friday afternoon and through the night brought dike maintenance almost to a standstill, said Engineer Ruyack. Bulldozers were kept off the tops of primary dikes because rain made the clay slippery. Workers placed snow fences along the inside of dikes to prevent erosion.

Two-person dike-walker patrols kept in constant touch with the Corps of Engineers by Citizens Band radio. The Corps increased its patrols to nearly 40; the city provided 30. All were watching for dike erosion and seepage.

The flood claimed its only victim on Friday. John Henry, 48, was declared missing and presumed drowned after a truck he was riding in with two companions left the highway and plunged into the Souris. As the truck began floating downstream, all three clambered out of the cab and attempted to swim about 125 feet to safety. Two men riding in a car behind the truck who had witnessed the accident plunged into the water and rescued Henry's companions. A tire was thrown to Henry but he was unable to hang on and disappeared in the Souris.

Saturday, April 17—"STILL HOLDING AND WAITING," headlined the Daily News.

Photo: Minot Daily News

The Souris River during a dry spell, as above, is a bare trickle compared to the mighty torrent that inundates thousands of square miles of North Dakota during some spring thaws. It has gone on such rampages more often than not in recent years.

This was to have been the day of crisis, when the river was to crest, but things were now uncertain, said Barnicle in his morning report. "We haven't been able to get a good handle on the effect of the rain on the crest." He said at 6 a.m. rainfall measurements ranged from 1.7 inches at Minot, to 1.38 inches at Lake Darling, to 1.18 inches at nearby Baker's Bridge. He thought the crest might now be delayed a day or two and possibly be revised upward to the original April 8 prediction of 57 feet or 8 feet above flood stage. He predicted limited showers and perhaps a few snowflakes over the basin early in the day and that afterward clearing weather would move in.

Stage reading at Broadway Bridge that morning was 55.4 feet, 6.4 feet above flood stage. Barnicle said a new, computerized forecast would be available in the afternoon giving a new prediction of the crest and its time of arrival.

City officals said there was a desperate need for volunteer sandbaggers and dike walkers and pleaded with the television viewers to pitch in.

Engineer Ruyack said, "Give us a little drying weather and we'll be ready. There has been some erosion, but the cores of dikes are holding well."

Both Barnicle and Ruyack said it appeared the rainfall upstream from Minot was lighter than it was in the city—"a good thing." They said, "We had expected a fast rise on the Des Lacs River flow and that hasn't happened."

Meanwhile, reports were coming in from outside the city of devastating effects on farmland. "Just about every valley farm is under water," said Edwin Heilmann, chief deputy sheriff of Ward County. County agents reported 400,000 acres of farmland under water in four counties along the Souris. The river was said to be a mile wide from Lake Darling downstream to Minot, where it funneled into the narrow channel lined by dikes. Elsewhere it was said to be as much as two miles wide. County agents said flooded farmland could not be cultivated for at least six weeks, if at all. Some farmers and ranchers had evacuated for the fifth time in six years.

Emergency housing for flood evacuees was becoming better organized. A good example was the former Minot Business College, whimsically renamed "Flood Palace." It housed 80 displaced Minot residents. The Department of Housing and Urban Development was paying the owner $8.50 a day for each of the 48 rooms or about $400 a day total. Marilyn Fishbach, a social worker who volunteered to help organize the shelter said: "This is the happiest bunch of flood victims I've ever seen." Residents were bused three times a day to a nearby school for meals. The Seventh Day Adventist Church had set up a daytime program for children, and families were given privacy in sleeping accommodations. Other evacuees were living in the Minot YMCA, YWCA, a church, apartment houses, hotels, motels, and with friends and relatives.

Out on the dikes, patrols with CB radios were proving the effectiveness of this technique of communications. City employee Greg Furness, who coordinated part of the effort, said the radios allowed "us to keep in constant touch." The city leased the radios for about $30 per week.

City Council President Edward Schmit said that a continuous patrol of 50 or more dike walkers wearing lifejackets and carrying walkie-talkie radios was out on the dikes, day and night watching for cracks, mounds or seepage indicating erosion. He said no major repairs had been needed up until that time. Although rains had kept trucks off the dikes, snow fences, polyethelene sheets and sandbags were taking care of what were called minor problems. He said greatest erosion was taking place west of town and at curves in the river.

In his noon report Barnicle confirmed that the heaviest rainfall had occurred in Minot and just downstream, and luckily not upstream from the city. He said the Kansas City computer was predicting a crest of 57 feet very briefly the following day at Broadway Bridge. The rain had ended and the weather was improving.

Engineer Ruyack said the dikes probably did not have sufficient freeboard to take care of the extra 1½ feet of water now being predicted and that emergency actions would be needed.

Saturday afternoon brought the most dangerous situation for Minot during the entire flood fight. At the point where the almost-mile-wide river was constricted into a narrow channel the water rose very rapidly during the afternoon, pushed by a strong wind against the dikes. At this point there was only four inches of freeboard above the lapping waves. He said this was the closest the town came to losing the battle with the river.

James Ruyack reported there was an amazing turnout of volunteers who formed a human chain on top of the dikes putting sandbags in place. He said that within a matter of hours they had provided at least a foot of freeboard.

At the 10 p.m. Saturday report, Ruyack said the Fish and Wildlife Service had suggested lowering a gate on Dam 96, the last structure between Lake Darling and Minot and that this might lower the crest the following day by as much as a foot.

Barnicle reported that the flow was decreasing now at Lake Darling, and agreed with Ruyack that the closing of Dam 96 might lower the predicted crest downward from 57 feet. He hazarded an estimate of 56.3 feet at about 9 a.m. Sunday.

City Manager Arnold said the "volunteer sandbag effort was great!" He reported that 200 persons responded in one hour, 50 of these from the Minot Air Force Base and 150 from the National Guard. He said there would be sandbaggers standing by all night, and a "citizen's watch" of some 60 people in the evacuated areas, along with 30 military police, auxiliary police and city police, to provide protection of evacuees' homes and belongings.

Easter Sunday, April 18—There were many prayers of thanks in Minot this day. The crest of the Souris River flood of 1976 had passed Broadway Bridge at 4:30 a.m. The level: 56.08 feet. Rate of flow: 10,100 cubic feet per second.

Mayor Reiten at the 7 a.m. report said that Saturday had been the grimmest period in their fight with the flood. "It appears today the crest was reached and the river is going down."

Barnicle said he now had nothing but good news. A low-pressure center was moving away from Minot. The sun should come out in the afternoon, and there was no precipitation in sight for 48 hours.

Engineer Ruyack wished everyone a happy Easter and said, "We owe a lot of thanks to somebody."

Mayor Reiten closed the session on a note of optimism, saying this Easter Sunday "may indeed turn out to be the good benchmark day we had been hoping for—the day we started the decline of the flood."

For the Reverend David Badgeley of the First Congregational Church, who told his flock that "out of the crisis comes the spirit of cooperation," it was unusual in more than one way. Mr. Badgeley said that after the service he witnessed one of the most moving experiences of his entire ministry when the collection plates were passed among the congregation. "Halfway through the offering the ushers had to return to the altar to empty the plates, they were so full. . . . It was the first time I ever saw that happen."

The days that followed Easter Sunday brought good news and a gradual lessening of tensions in Minot. The Souris fell below flood level on May 14 at Broadway Bridge.

But the townspeople, skilled as they are in mobilizing forces to meet and hold the Souris in its periodic rampages, feel they've had enough. They want better protection. Several plans are being considered by the Corps of Engineers and the Fish and Wildlife Service. Will a way be found for the Souris to be permanently tamed amidst a still-harmonious setting of man and nature?

One thing seems certain. The effort will be made. □

A growing trend in flash-flood protection

The Towns That Help Themselves

IN stark contrast to the slowly rising river levels heralding snowmelt flooding in which millions of acres in a vast river basin may be inundated, the flash flood is a sudden, darting killer.

Its track is narrow, its ferocity is incredible, and then—after striking with little or no warning—it's gone, leaving behind a path of almost total destruction.

Brought on by very heavy rains or the sudden release of water from some natural or manmade barrier, the flash flood may course down a hillside uprooting trees, rolling large boulders, gouging out new channels, sweeping virtually everything before it in a deadly turmoil of mud and debris. If man or his works get in the way, so much the worse.

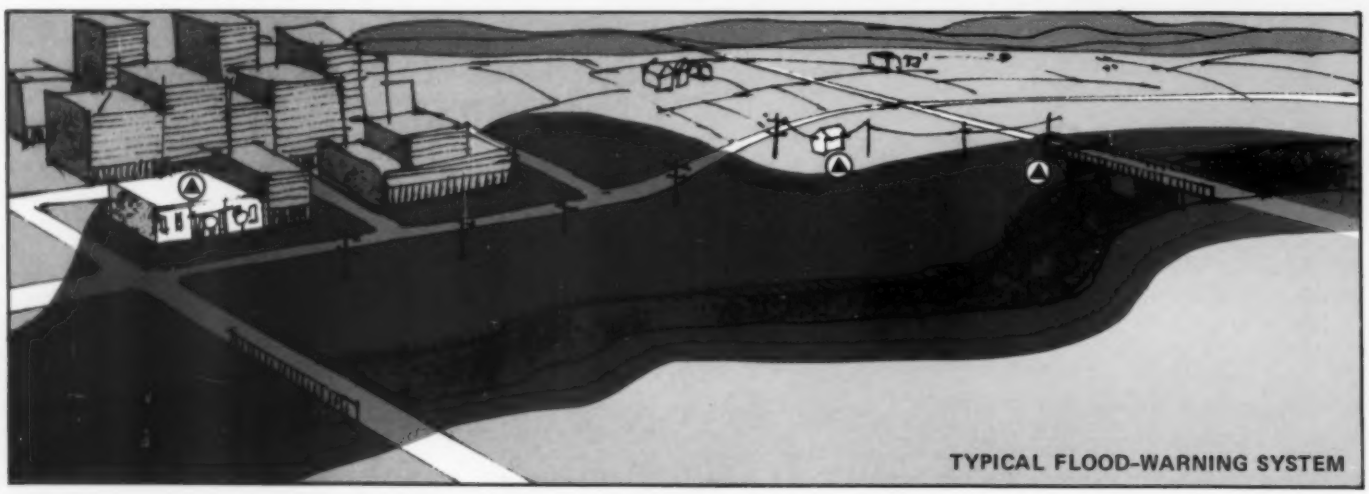
Reminders of the lethal nature of such torrents are found in accounts of the drowning of 153 people in Virginia in 1969 when the remnants of Hurricane Camille dropped 27 inches of rain in about eight hours bringing on flash flooding in western areas of the state. Of more recent memory is the Big Thompson Canyon flash flood disaster of 1976, in which 135 persons lost their lives in Colorado.

The National Weather Service is acutely aware of the flash flood warning problem. As in other areas of forecasting, the ability to predict flash flooding with any degree of accuracy is limited by the lack of observational data. In mountainous areas where flash floods are a perennial hazard to small communities and campers, information on rainfall intensity and duration and streamflow and levels are simply unavailable. Radar data is helpful and flash flood watches and warnings are issued by the Weather Service based on indications from such sensors. But hydrologists, recognizing both the limits of flash flood predictability and the problems of disseminating the hazard warnings in a timely manner, have for some years recommended that communities initiate action to help themselves.

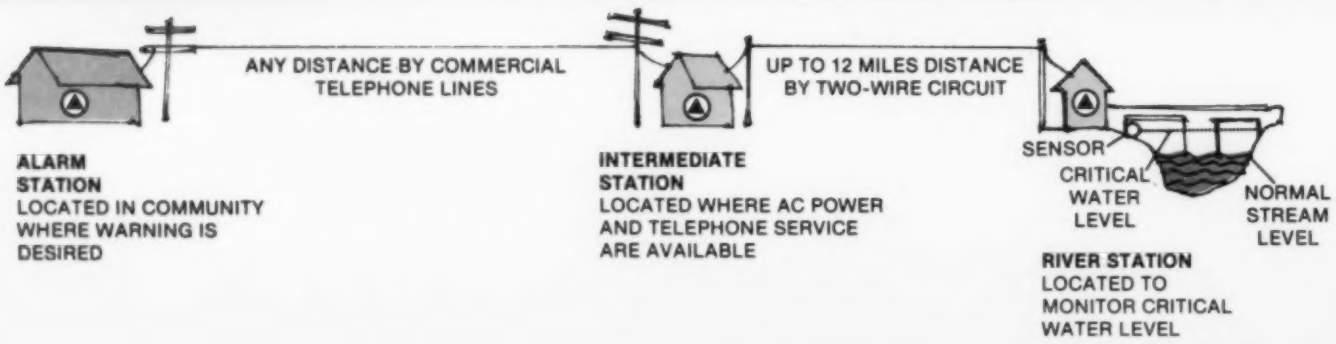
The Weather Service is ready to assist and its staff of professional meteorologists and hydrologists is available to go into any community which asks for help with advice on the best plan for flash flood preparedness. But it is the community which must finally bear the responsibility for self protection—just as it must with such hazards as fire and crime.

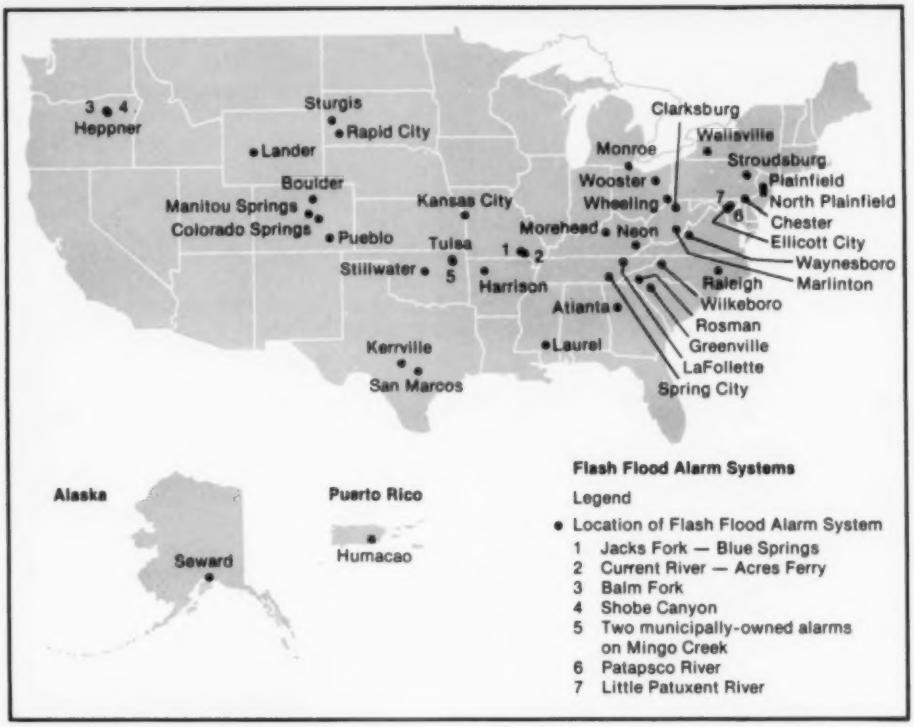
A key element in this "do-it-yourself" program is a relatively inexpensive flood alarm system which has proven itself again and again as a reliable warning device.

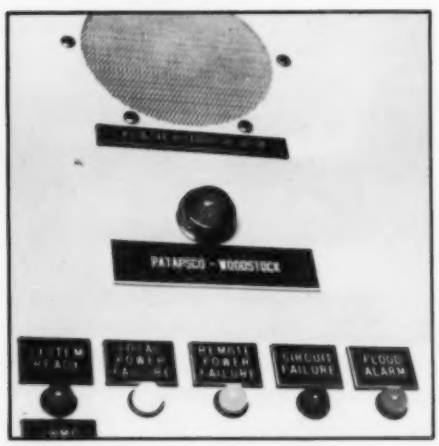
The flash flood alarm system is a fairly simply electro-mechanical set-up comprising three main components. An enclosed float device is installed—perhaps on a bridge piling—at a critical point upstream from the flood-prone area. If the upstream water level rises to a predetermined critical height, the float is lifted and triggers an electrical impulse (provided by a storage battery). The signal goes to an intermediate station—located



TYPICAL FLOOD-WARNING SYSTEM


ANY DISTANCE BY COMMERCIAL TELEPHONE LINES
UP TO 12 MILES DISTANCE BY TWO-WIRE CIRCUIT
SENSOR
CRITICAL WATER LEVEL
NORMAL STREAM LEVEL
ALARM STATION
LOCATED IN COMMUNITY WHERE WARNING IS DESIRED
INTERMEDIATE STATION
LOCATED WHERE AC POWER AND TELEPHONE SERVICE ARE AVAILABLE
RIVER STATION
LOCATED TO MONITOR CRITICAL WATER LEVEL





where both commercial electric power and telephone service are available. From this second location, the signal flows to an alarm station in a facility manned around the clock, such as a police or fire station. Here an alarm, a flashing light and buzzer, alert those on duty to the upstream rise in water. Local public safety officials are then responsible for warning the community of the danger and recommending actions to prevent loss of life and reduction of property damage.

There's not much to go wrong, and not much does.

Late in June of 1972, heavy rains from what was left of Tropical Storm Agnes began to push stream levels farther and farther above their normal heights near Wheeling, W. Va. While most people in the area were still asleep on June 23 the flash flood alarm on Big Wheeling Creek was triggered. Alerted officials were able to warn the people of the danger and families in vulnerable areas of the city were evacuated as creek waters rose. Again in 1975 an ocean storm—this time the remains of Hurricane Eloise—brought heavy rains to the Ohio Valley and threats of flash flooding to the Wheeling area. And again the flash flood alarm system (this one on Wheeling Creek near Viola) sounded in the early hours of the morning. The citizens were alerted to the threat, which less than six hours later became a reality as large outlying areas of Wheeling were well under water.

Getting the word to flood-threatened areas that evacuation will be necessary is a vital part of any warning system. But the flash flood alarm system at Rosman, N.C., allowed city officials time to study the flood situation and recommend that evacuation *not* be undertaken.

Heavy rains were soaking the mountains west of Rosman on March 16, 1973 when the city's alarm went off, warning that the French Broad River was within two feet of flood stage and rising rapidly. Officials began a concentrated vigil to determine if evacuation would be necessary. The river—carefully observed by Civil Defense and others—crested, the rain slackened and the river began receding. It was a near thing, but the early alarm had made possible a clear decision not to evacuate, saving considerable effort and expense.

Joseph J. Powers, police chief of Scotch Plains, N.J., wrote the National Weather Service in 1973:

"On February 2 at 13:44 hours, we were called by the Plainfield Police and advised that they had received an alarm from the sensor. Our Patrol was dispatched to check the area and reported that the water was indeed high and continuing to rise. Thanks to this advanced warning, we were able to contact the State Highway Department, Civil Defense Headquarters and Public Works Department, and arrange to block off known areas of flooding and divert traffic away from these spots. Being able to plan properly, we were able to save unknown amount of damage to motor vehicles which would have been caught in these floods and many extra manhours required to move them after the waters receded."

The mayor of Spring City, Tenn., had this to say about the alarm in 1973:

"The warning system is working great. After the warning system was installed each time Piney River has gotten to flood stage, the alarm has given about 2 or 3 hours time for the people to vacate the flood area. We are happy with the system, the timing of the alarm, and everything."

A real test for two flash flood alarm systems on the Jacks Fork and Current Rivers in Missouri, came on January 10, 1975—*the day after they were put into operation.* At 1:30 a.m., about 10 hours after the hook-up was made, both alarms sounded. The Jacks Fork alarm went off in the face of a 19-foot rise of water. U.S. Park Service Rangers on both rivers activated local plans to warn downstream interests. The alarm systems gave several hours' lead time and no deaths were reported from the floods.

Richard Barlow, director of Pocahontas County (W. Va.) Emergency Services, has nothing but praise for the alarm and the backup provided by the National Weather Service during an emergency in October of 1976:

"We were getting some heavy rain in Pocahontas County, the most heavy being in the Greenbrier River water shed. At 11:30 p.m. on October 8, the flash flood alarm on the Greenbrier at Cloverlick went off at 3.5 feet, which, combinded with readings at other points meant that we would be at flood height in four hours or so. The Greenbrier at Marlinton was 10.2 feet on October 9. With the facts and figures supplied by the Elkins and Charleston Weather Service and the flash flood book that Cincinnati had prepared for us in 1974, we were able to figure the rise of the river very close as to height and time of crest of the Greenbrier River. . .

"I felt that this system gave the Emergency Services and the Fire Department some very valuable time to prepare for and evacuate between 500 and 600 people and warn businesses and the local hospital so they could prepare for the high water. There was 10 inches (of flood water) in Main Street, two feet in Fas Chek, and two feet in Burns Motor Freight to name a few. This system more than paid for itself in this one flood."

These examples of the utility of the flash flood alarm system are most encouraging to the National Weather Service. In particular, hydrologists are pleased to see the self-help concept taking hold at the local level. The personnel and equipment needed to maintain observing stations at the thousands of critical points along the Nation's streams and river tributaries are quite beyond the Weather Service's resources, but they can and do help local authorities who, in growing numbers, are determined that their communities will not be caught unprepared by a flash flood. □

BE ALERT, HAVE A PLAN, MOVE FAST,

THINK FLASH FLOODS - WHENEVER IT RAINS!
FLASH FLOODS OCCUR IN HILLS AND MOUNTAINS; IN VALLEYS AND CANYONS. THEY OCCUR WHERE TREES HAVE BEEN CUT DOWN TO MAKE WAY FOR HOUSES AND SHOPPING CENTERS.

OWLIE SKYWARN ON

FLASH FLOODS

LISTEN TO THE RADIO AND TV FOR NEWS ABOUT FLASH FLOODS.
CAMPERS - WHENEVER IT RAINS, KEEP A BATTERY RADIO TUNED TO NEWS.

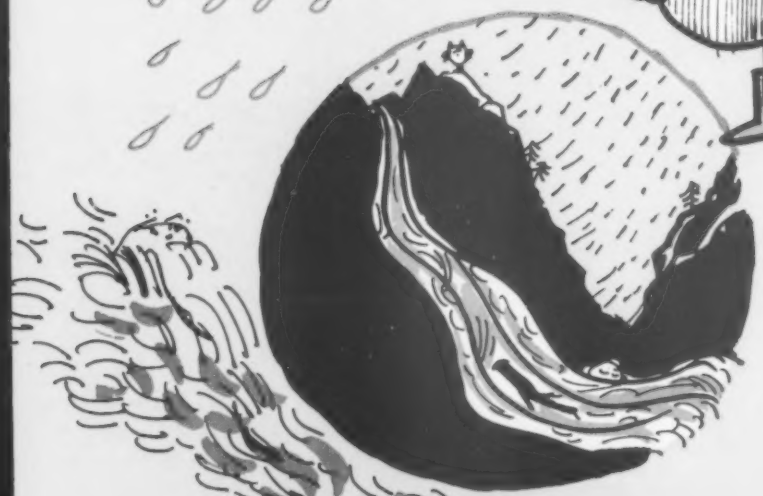
FLASH FLOOD **WARNING** - MEANS - **ACT AT ONCE** - DONT WAIT 'TIL THE FLOOD REACHES YOU.
KEEP AWAY FROM STREAM BEDS.

IN TOWN KEEP AWAY FROM STORM DRAINS AND STREAMS.
SAFE, SHALLOW WATER MAY GET DEEP AND DANGEROUS IN ONLY A SECOND OR SO.

SECONDS COUNT, GET TO HIGH GROUND!

FLASH FLOOD WATCH
THERE MAY BE FLOODING.
KEEP LISTENING.
WE'LL LET YOU KNOW.

FLASH FLOOD WARNING!
THERE IS FLOODING.
MOVE OUT.
GET TO A SAFE AREA.



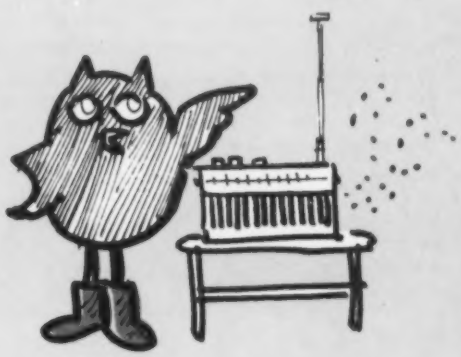
KNOW WHERE THERE IS HIGH GROUND, AND HOW TO GET THERE. MAKE PLANS. BE READY TO GO. SECONDS COUNT. FLASH FLOODS HAPPEN IN A **FLASH!**

IF YOU'RE IN A CAR WATCH FOR FLOODING AT BRIDGES, AND WHERE THERE ARE DIPS IN THE ROAD.

FLASH FLOODS CAN PICK UP CARS, ROLL HEAVY BOULDERS, KNOCK DOWN TREES, RIP OUT ROADS AND BRIDGES.

IF THE CAR STALLS, GET **OUT - LEAVE IT.** CLIMB TO HIGHER GROUND. RUSHING WATER COULD CARRY THE CAR AWAY AND YOU WITH IT.

AT NIGHT YOU CAN'T SEE THE DANGERS OF FLASH FLOODING. BE ESPECIALLY CAREFUL. ALWAYS KNOW WHAT TO DO. YOU MAY SAVE YOUR **LIFE**, AND THE LIVES OF OTHER PEOPLE TOO!



AFTER THE FLASH FLOOD IS OVER — KEEP LISTENING TO RADIO AND TV. THE FLOODING MAY SPREAD OUT - LARGE AREAS MAY BE UNDER WATER.

KEEPING A WATERY EYE ON THE UNIVERSE

By KURT STEHLING

THE Hawaii meeting is one we've seen before. Leading scientists from around the world converge at a university, where, in a new concrete and glass tower of modern design, they share ideas, let their talents range. They confer in the hope of finding a way to bridge some crucial gap in human knowledge.

The problem confronting scientists meeting in Hawaii last September was a cosmic one. If the pervasive flow of energy from galactic and intergalactic space could be read in greater detail, it would be possible to infer the birth and the collapse of stars, opening new perspectives on fundamental processes in our universe. These new perspectives would in turn illuminate that corner of the physical world where matter and energy become much the same thing, perhaps help solve some of the problems of harnessing the energy of fusion. Energy annihilation and some radioactive decay or fission processes, and certain nucleon collisions, may produce sub-nuclear mass-less, charge-less, elusive particles called neutrinos. The more energetic the process, the greater the energy carried by the neutrino which moves at the speed of light. Neutrinos from nuclear reactors and cosmic rays have been observed indirectly via complex interactions with chlorine and other nuclei. Great numbers of neutrinos can also be produced by proton collisions with target nuclei in facilities like the Fermi National Accelerator Laboratory near Chicago. To produce neutrinos at energy levels comparable to those scientists believe emanate from galactic or other stellar sources, however, accelerators many times larger would be needed. Even the thermonuclear furnace of our sun has not sufficient energy to produce very high energy neutrinos.

Theory says the sun should produce lower energy neutrinos, but despite diligent searching they've not been found. These mass-less, charge-less particles are very difficult to detect. A high-energy neutrino encounters the earth, passes through the planet, and is gone in a small fraction of a second. To be seen, some portion of that transit—perhaps the billionth part of it—must be captured in a form that can be studied for clues as to when and where the particles began their galactic or interstellar journey. Such observations would be the cornerstone of a new science: neutrino astronomy. The ocean would be the site of the "telescope."

This is the rationale behind Project DUMAND, the acronym from "deep underwater muon and neutrino detector." It is seen as an opportunity by the world's high energy nuclear and astro-physicists to detect elementary particles at energy ranges many times—some say a thousand times—greater than is possible in the largest accelerators today.

The Project DUMAND workshop last September was directed by Dr. Arthur Roberts of the Fermi National Accelerator Laboratory in Batavia, Illinois, and supported jointly by NOAA, the National Science Foundation, the Energy Research and Development Administration, and the Office of Naval Research. It was the latest step toward what could be the largest ocean engineering project ever undertaken, one in which NOAA's Manned Undersea Science and Technology Office has been involved from the beginning.

This beginning came early in the decade, when NOAA and University of Washington scientists collaborated in a pioneering effort to determine how much filtering of stray cosmic ray shower "particles" (such as protons, electrons, etc.) would accrue from measuring or detecting selectively certain cosmic ray components under water. The experiments were conducted in Hydrolab, a habitat in about 50 feet (15 meters) of water, off Freeport, the Bahamas. As predicted, the water acted as an isotropic filter of essentially uniform density, (as contrasted with the overburden in mines, where other cosmic ray studies have been done) permitting the researchers to learn new data about cosmic ray muons—sub-nuclear charged particles far less elusive than the neutrino—on photosensitive plates, which had to be prepared, deposited, and a few weeks later developed in the Hydrolab. The plates were mounted in waterproof cassettes.

The MUS&T-University of Washington work attracted widespread attention from high-energy physicists and cosmic-ray researchers around the world. At conferences after the Hydrolab experiments suggestions were made that such work should be extended into the deep ocean—deeper than 10,000 feet (3,000 meters). There, the lightless ocean would provide the quintessential filter for sub-nuclear particles, admitting only very-high-energy muons and neutrinos with energies in the trillion electron-volt range.

Deep ocean detection is what DUMAND is all about. It is the kind of grandiose suggestion which is concomitant with contemporary "big physics and astrophysics" where bigger and bigger machines must be devised to look into, or detect, the subtle manifestations at the frontiers of the Universe or in the deepest recesses of the nucleus.

The DUMAND would be emplaced in a cubic kilometer of ocean water acting as the detection medium. Clusters of photomultiplier tubes—tens of thousands of them—would wait in a world without light for "Cerenkov flashes"—the ultraviolet and visible radiation admitted by a charged particle moving through a medium faster than light in that medium.

An alternative scheme by Soviet and U.S. scientists would use very sensitive microphones to detect the faint "hiss" of the neutrinos or collision product "Hadron" particles passing through DUMAND's array.

Even if installation of the DUMAND sensors were begun today, it is not a project that could come to fruition in a year, or a decade. And, in fact, there is much to do before the first photomultiplier cluster is anchored in the deep sea. These are the preliminary steps the DUMAND workshop recommended:

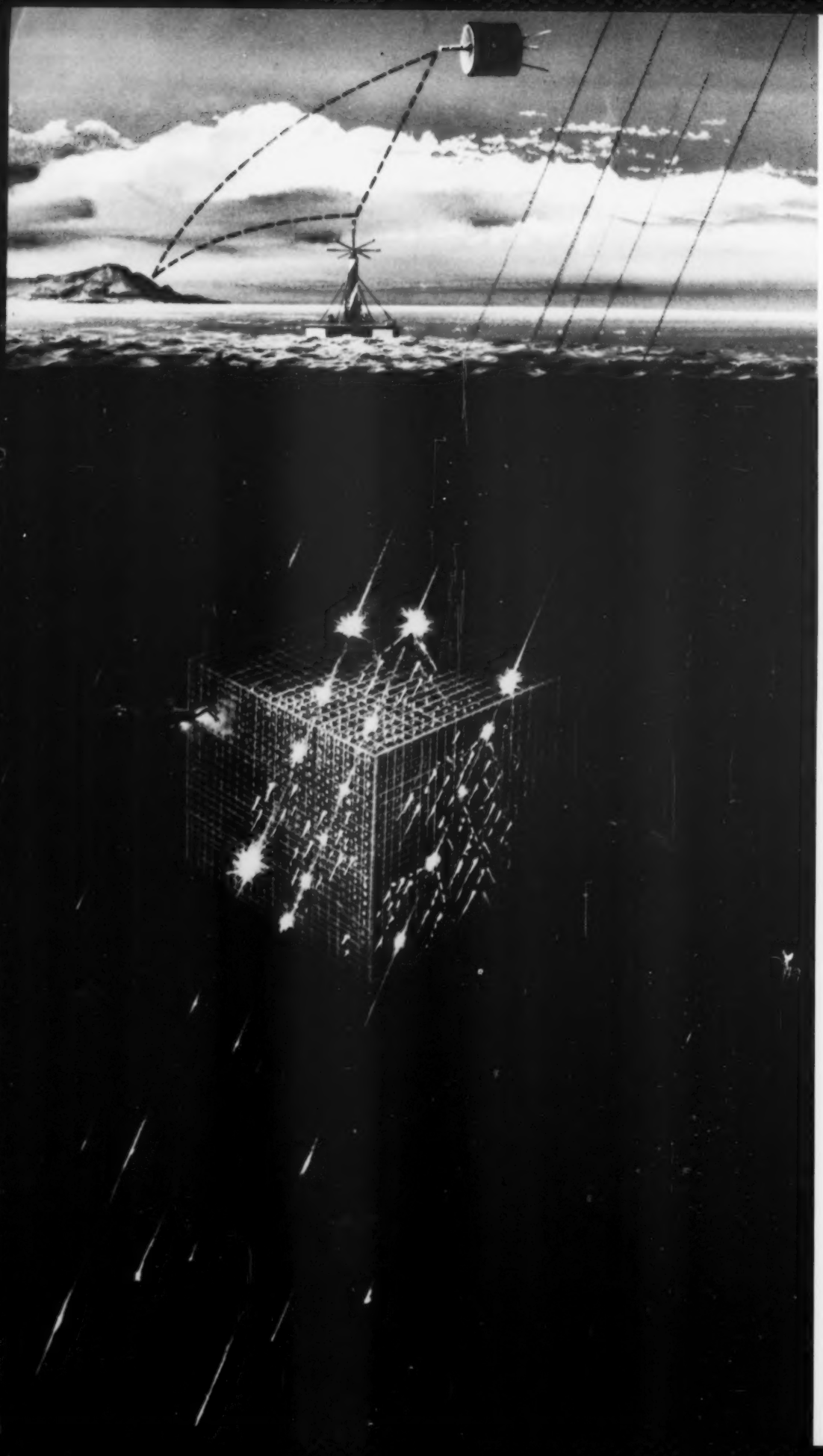
First, "proto-DUMAND" underwater experiments should begin at once, coordinated and partially funded by NOAA. The experiment would begin with a nephelometry turbidity survey piggy-backing at the Naval Undersea Center's remote underwater work system, to determine whether the deep water off Hawaii (suggested site for a DUMAND array) had flocculation, suspensoids, and other particulate matter which could obscure Cerenkov detection. A parallel experiment would be done to measure bioluminescence and ocean bottom geophysics there.

A series of tests at Brookhaven National Laboratory on Long Island have determined that highly energetic nucleons—for example, protons—generated sonic disturbances in water that could be detected by sensitive hydrophones. This pioneering experiment has proved that sonic "signatures" do occur but it remains to be seen whether neutrinos or muons produce these.

By mid-1977 a mini-array of photomultiplier tubes and, perhaps, hydrophones, may be proposed. If funded, it would take about two years to design, build, and deploy in the deep ocean, and could cost several million dollars.

If the small array were a productive research tool, work would begin on the full system, with the DUMAND deployed in about 10 years.

DUMAND is an astonishing idea, and an expensive one. But if it goes forward, it will give scientists a lens of ocean water, through which they will detect the fundamental processes which illuminate the otherwise undetectable manifestation of star or even galaxy collapse or formation. □



Incoming cosmic ray particles collide with atomic nuclei in the water producing a shower of secondary particles such as muons, which also collide with atomic nuclei, causing "Cerenkov flashes," which are detected by photomultiplier tubes in the underwater telescope.

The data from the telescope may be transmitted by cable up to a NOAA data buoy and thence to a satellite, which sends it to the laboratory on shore.

THE BIGGEST GAME IN THE ROCKIES

By JOAN VANDIVER FRISCH

WHEN the pager on Frank Merrem's belt begins to beep, it signals a few hours, a day, perhaps a week of uncommon work for Merrem and a band of modern mountain men; and it means that, at the end of a hard hike amid the Rocky Mountains, someone is waiting, or injured, or dead.

It beeps this afternoon, and Merrem and Rocky Mountain Rescue Group, Inc., move into action.

Merrem contacts the Boulder County sheriff's emergency dispatch center and learns that two young mountaineers are stranded on the slopes of 13,000-foot Mt. Audubon. They are suffering from frostbite and hypothermia—a condition in which the human body has begun to lose the fight to stay warm.

When he hangs up, Merrem, a computer specialist with ERL's Wave Propagation Laboratory, telephones the Rocky Mountain Rescue dispatch center on the University of Colorado campus.

"This is Merrem," he says. "We'll need 20 to 30 people equipped for high altitude winter mission. Call out the snowmobiles and check with St. Anthony's Hospital about possible helicopter rescue."

RMR, the oldest mountain rescue group in the United States, handles calls for help only in mountainous terrain and steep rock where vehicles can't operate. Most calls are for injuries, lost persons, fatalities, and plane crashes. A typical mission may be the technical rock evacuation of an injured climber or a search in the Rocky Mountains for a lost child, camper, hunter, or tourist. On call 24 hours a day, seven days a week, RMR recorded 143 calls for assistance in1976.

About 60 percent of the calls required RMR members to carry out search and rescue operations on foot. Of those, about half occur in the late spring and summer months when people begin hiking and camping in the mountains. The other 40 percent of the calls are handled by telephone. These calls include overdue people who return before RMR gets mobilized, standby calls from other mountain teams, and calls that should be referred to other agencies.

In the fall and winter RMR receives fewer calls—usually from the worried families of lost or overdue hunters or cross-country skiers. But larger search efforts are required because the lost or injured victims are located in more remote areas, and the operations are complicated by cold and snow.

Now Merrem hurriedly flings his down parka over his shoulder and sprints to his radio-equipped car. There is little time to waste. He switches on his mobile radio and hears Bruce Bartram, another ERL staff member, radioing that he will pick up RMR's four-wheel drive vehicle and two additional RMR members.

On his way out Bartram, an electrical engineer with the Wave Propagation Laboratory's meteorological radar program, gathers his ice axe, snow shoes, hiking boots, helmet, additional warm clothing and mountaineering equipment, and enough trail food for 24 hours. He has been a member of RMR for more than five years and is the youngest senior-ranking member. He always still takes the extra moment to check that he has not forgotten anything essential.

He meets Merrem about an hour later at a mountain parking lot where a huge snowdrift closes the road to the base of Mt. Audubon each winter.

"What's the story, Frank?" Bartram asks.

"Two girls were descending the slopes of Mt. Audubon about noon today and ran into the two fellows in trouble above timberline," Merrem explains. "The girls got them slightly sheltered from the wind, left some food and clothing, and skiied down to the mountain club hut. They radioed the sheriff's office. We don't know exactly where the men are because blowing snow prevented the girls from fixing the exact spot. But the two victims are somewhere east of the cirque and above the trees."

The look up into the blowing snow of the

Frank Merrem of ERL (above) using radio in his car to get update on rescue efforts; Army Chinook helicopter dropped rescue team members and litter at 12,000 ft. near Continental Divide, to recover bodies from wreckage of aircraft.

Members of Rocky Mountain Rescue group practice ice climbing in Boulder Canyon (left), and carefully rehearse "worst case" rescue techniques on rock across narrow canyon (above), where "victim" will be brought vertically up to camera position.

ERL's Bruce Bartram (r.) and Lewis Dahm, designer and builder of RMR's custom made winch, test the system—which can raise or lower a litter at 120 feet per minute.

ominous lee-wave cloud perched on the Continental Divide. The cloud forms when the violent underside of the jet stream hits the jagged Indian Peaks. Somewhere up there, in the treeless expanse of rock and snow, are two young men whose bodies have been robbed by cold, and are not generating enough heat to keep alive indefinitely.

Merrem, the mission coordinator, remains at this base camp, and Bartram moves out with two other RMR members, leading the search. The first mile and a half is done on snow machines. Then they strap on snowshoes and continue the trek through a darkening forest. The snowmobile operators return to the base for more back-up teams, and several hundred pounds of specialized rescue equipment.

Some of the equipment has been specifically modified or custom-designed for the rescue organization. For example, a local mountain recreational equipment company designed and produced a sleeping bag used for RMR's rescue work. The customized bag contains a thick foam mattress, straps for taping to the litter, and many zippers and Velcro closings so that the trained volunteers can easily perform first aid without disturbing the injured victim's whole body. More than 200 man-hours were spent by group members in developing the special sleeping bag over a period of several years. The recreational equipment company donated the specially designed bag to the group when it was finally produced.

RMR also modifies some manufactured equipment for their special needs. Standard Stokes litters, as made for the U.S. Navy, are modified by RMR by cutting the seven-foot (2-meter) steel basket strechers in half crosswise so the litter can be carried to the injured victim on a backpack and reassembled on site. The rescue group has also had their newest litters modified so that they have solid stainless steel bottoms instead of chicken wire, enabling the stretchers to slide easily in snow. The stainless steel also prevents rocks from hitting victims when the litters are set down in hazardous terrain.

Today the men and equipment are being given rigorous tests. The early optimism that they might get to the stranded men before nightfall vanishes with the sun, and, in the shadow of the mountain, temperatures fall. Bartram and his two companions continue to push up the mountain through the snow.

Back down the slope, Merrem catches the faint slap of rotors, coming toward him up the valley. The St. Anthony Hospital helicopter pilot radios that he's making an approach to the mountain, but that winds are very bad. Merrem tells the pilot RMR people on snow machines will meet the chopper at Brainard Lake. The helicopter sets down there briefly, offloading what surplus weight it can along with a flight nurse. Then the bright orange chopper is off again. Merrem watches it go. The pilot runs close to the slope of the mountain in the hope of beating the winds, but after twenty minutes of trying to land higher up the mountain, he knows it is no go. The chopper turns back to Brainard Lake, picks up the flight nurse and gear, and heads back toward its Denver heliport.

RMR runs partly on close interaction with organizations like St. Anthony's, and with the business community. For example, when an 8-year-old boy was lost for over a week in the wilds of Wyoming, a regional airline flew members of the search and rescue group on a standby basis to the nearest airport free of charge. The same airline also flew RMR members without payment to the Four Corners area at the junction of Arizona, Utah, Colorado, and New Mexico state lines for another rescue operation.

A local tire and rubber manufacturer in Denver donated tires for the group's four-wheel drive vehicle. A large typewriter and computer manufacturer in the region donated $1,000 to pay for typesetting the organization's book on search and rescue techniques.

The ground rescue continues in total darkness; headlamps throw cones of light along the mountain. More volunteers arrive and are ferried by snowmobile partway up the trail. Bartram and his advance team have reached timberline, where wind-tortured, stunted pines give way to tundra and rock. The fierce winds have scoured the snow off the bare mountain face, and they remove their snowshoes. Wearing three and a half-inch thick down parkas, heavy double boots, waterproof gators, thick wool mittens, knitted face masks, and goggles, Bartram and team scramble along the mountain's treacherous rocky slope. The horizontally blowing snow has destroyed any trace of the two girl's tracks after they left the victims.

As Bartram and his team brace themselves against the freezing, blizzard-like conditions, the 24-year-old ERL engineer attempts to make contact with other RMR teams scattered along the rocky ridge behind them. The inhospitable conditions make it difficult to communicate via radio because howling wind obscures the message.

Meanwhile, another RMR team not too far behind picks up the girls' tracks in a sheltered area and abruptly comes upon the two disabled mountaineers. The two young men had been sufficiently clothed and sheltered to sustain life. Because the victims' major problems were hypothermia and frostbitten extremities, the RMR rescuers hurriedly set up the small tent, and put each victim in a sleeping bag with a volunteer, using the warmth of another human body to decrease the hypothermia.

Bartram immediately radios Merrem at the parking lot to inform him that the victims have been found and explains their conditions. He also gives the mission coordinator the altitude at their position, a description of the route, and the number of other rescuers who have arrived.

Merrem informs Bartram that litters for the two victims should arrive within the next hour and that 20 to 40 more RMR volunteers are on their way up to help carry back the victims and equipment.

The number of volunteers needed by a rescue group depends upon the number of victims to be rescued and the walking distance from the organization's vehicles. For example, if an injured victim could be reached within an hour's hike from the road, only about 12 RMR (six on a litter at one time) volunteers would be needed to rescue the person. However, if two victims were injured six miles from the road, about 60 people are needed.

The two college-age victims are loaded onto stretchers inside the small tent. Bartram gives each victim a last-minute medical checkup before he and the other RMR litter bearers break for treeline about one-half mile (1 kilometer) away. As the rescuers make their way gingerly down the steep mountain face, Bartram and his companions have only their head lamps to guide them.

The weary young engineer and the other litter bearers meet more volunteers at timberline and gladly transfer their heavy human cargoes to the fresh teams. The second set of volunteers head down the trail on snowshoes, dragging the litters behind them over the deep snow drifts. Within another half hour RMR rescue teams welcome the site of the snowmobiles, which transport the two victims on custom snowmobile sleds down to the parking lot. Both victims, physically numb from the long ordeal, are carefully placed in a waiting ambulance which winds its way down the deserted mountain road amid flashing red lights and the scream of sirens on its way to Boulder community Hospital. The ambulance passes within a few miles of what was probably the birthplace of the Rocky Mountain Rescue Group three decades ago. A small girl was missing from her mountain home west of Boulder, and local mountaineers had been called out to search for her. They found nothing. It was only later that the small body was discovered near her home, and only a few feet from the tracks of the earnest but untrained searchers. Mountaineers formed RMR in the spring of 1947, to provide an organized, highly skilled mountain rescue team that could cheat the mountains of such victims.

The bulk of the RMR members began arriving back at their cars in the parking lot soon after. No cheers, words of thanks, or smiles greet the weary volunteers. But Merrem, Bartram, and the remaining RMR members know that once again, through their collective efforts, two men are alive. □

NOAA Profile

BILL WICK: LIVE WIRE IN OREGON

By BRIAN E. GORMAN

HOW does a man who started his career as an antelope trapper emerge as one of the Nation's premier spokesmen for marine science and education?

For William Q. Wick, Director of Oregon State University's $2½ million Sea Grant program, and recent winner of the Compass Distinguished Achievement Award for pioneering performance in marine advisory services, it's perfectly logical.

"A good wildlife biologist has to be interested in all living things—including people," Wick says. "In my case, it happens to be people who live by fishing, who manage the shoreline and its creatures, who own waterfront property, and others who can learn a great deal about themselves and their community by discovering how the marine environment affects them and their neighbors."

That philosophical interest in the interactions of people and their environments took a practical turn immediately after Wick received his Master of Science degree in fish and game management from Oregon State University in 1952. "I went to work for the Fish and Game Commission in Nevada that year, managing antelope and chukar partridges. The following year, I was back closer to home, as well as to my metier, working as a waterfowl biologist for the State of Washington's Department of Game."

By 1960, Wick had moved a few hundred miles farther south—to Oregon—and a quantum jump closer to his own forte—working directly with people—to become a county extension agent at his alma mater, Oregon State University. "That initial experience as a county agent, working in the coastal county of Tillamook, convinced me of the efficacy of the Cooperative Extension Service techniques in marine resource development," Wick recalls. It also gave him the opportunity, a few years later, to justify that belief as coordinator of extension programs at Oregon State University's new Marine Science Center at Newport.

"I came down to the Marine Science Center in early 1967. And I immediately had to deal with two very disparate but important groups, scientists in their labs and masses of kids and teachers and parents and tourists

Wick (right) explains OSU's aquaculture facility to U.S. Representative Les AuCoin.

from all over the Pacific Northwest, in fact all over the world, who had come to see this wonderful aquarium/museum. That was the beginning of what I think is a very good public education program." If the sheer number of visitors is any standard of measurement, "very good" doesn't tell the whole story. Last year, Oregon State University's Marine Science Center saw some 376,000 visitors. That's almost twice as many persons as lived in the entire state of Nevada when Wick embarked on his career, 25 years ago.

As coordinator of extension programs at the Marine Science Center, Wick asserted that one of the best ways to achieve enlightened public policy regarding development of Oregon's marine resources was to create an enlightened public—through extension programs. "In a way, I was fortunate. I had no precedents, no tradition to follow in those days," he remembers. As a result of this freedom, the Center produced lecture programs, displays, aquarium tours, and school field trips. And people began doing what educators dream they will do: learning about marine science painlessly, often without realizing they were part of an educational process, sometimes even in spite of themselves.

By 1968, when the first four Sea Grant programs—including Oregon State University's—were started, Wick had already established a fisheries extension service under the Commerce Department's State Technical Services Act. "The Sea Grant Act said, 'there shall be an advisory service,' and here we were with the foundation for one before things even got started," Wick says.

Wick was ready to create a broadly based, interdisciplinary team of marine extension agents and area specialists who, acting in concert, would be able to help solve some very real economic, technical, biological, and human problems in the state.

"It all seemed so logical," says Wick. "With the help of Extension Service Assistant Director Joe Cox, I argued that the Marine Advisory Program should be under the Cooperative Extension Service because then the advisory staff could take advantage of the resources, techniques, accumulated knowledge, and experience that our staff in Extension already had."

With his idea approved by the Oregon State University Sea Grant Committee, Wick set out to prove the value of his idea by hiring experts in a wide variety of fields. The first had a background in fisheries and in business. He became a marine extension agent. A physical oceanographer became the country's first extension oceanographer. An industrial engineer brought his knowledge of agricultural food processing to Oregon's seafood processors. A communications specialist helped other staff members translate their ideas and research results into useable information. Marine science education specialists began carrying on the work that Wick himself had begun.

The physical and biological diversity of the ocean environment is such, Wick believes, that no group of specialists in a single area of expertise is sufficient to grapple with the problems created by that diversity. What Wick wanted, and achieved, was to make those first 11 marine advisory staff members

As Director for OSU's Sea Grant Program, Wick's views are frequently sought by the public. Here he is being interviewed by Carol Wisner of radio station KFLY.

realize that they had to see the whole picture, the identify its parts, and then to set out synergistically to solve problems. "But I couldn't just sit back and tell them what to do," Wick explains. "In the first place, the staff had been chosen in part because of the independence and imagination of its members. We had to capitalize on that. And, too, I didn't know the answers. Sometimes I didn't even know the questions."

His solution was to provide the setting and circumstances for a staff he trusted and to let it go about its business in ways its members thought best.

But just as the marine advisory staff had to realize that its element, the ocean, was part of a greater whole, so too did it have to be convinced that it was part of a university community. As such, it had a rare opportunity to become a part of that community. Wick explains:

"It became obvious that Sea Grant had an opportunity that Land Grant never did have. Sea Grant and Land Grant are so-called analogues. But when you analyze this, you realize that it was not always the case. When Lincoln signed the Land Grant Act in 1862, he was talking about public universities, but the research function wasn't added until 1887 and the extension function didn't come along until 1914. The progression was sequential.

"Sea Grant *started out* with these three functional mandates—research, education, and advisory service—together. And we'd better keep them together. Advisory service can't be out here saying: 'We respond to the needs of the people. We take the talents we have and we solve the problems but we don't have to relate to the greater university.' I don't buy that. I'm forcing them back together."

One aspect of this togetherness is Wick's insistence that every Sea Grant research project have an identifiable advisory service objective. At the same time, when a problem is identified by the advisory service that could best be solved through a research project, the research leadership is informed. If a research project actually results, an advisory service member is assigned to the researcher as a "friend of the project."

The advantage of this system, claims Wick, is that both the researcher and the advisory agent are able to use what he calls extendable results as soon as they begin to appear, usually long before a paper is published in a scholarly journal.

"The results of the method are fascinating," Wick says. "In the past, many of our researchers have felt left out because they didn't have the chance to extend their research findings and see knowledge applied that they had generated. I'd never thought of that. As an extension person, I'd felt that the extension staff were sometimes left out because the research faculty didn't take us seriously. Now, by bringing both researchers and advisory staff together, we've proven that both those assumptions are false. And we're helping the public in the process."

But "helping the public" doesn't simply involve fish or shoreline erosion or safe boating or any of the classical applications of Sea Grant research and development. It means, more than anything else, making people realize that all of them are part of community, an enormous, at times intangible, community. However, that community can be made more tractable and less confusing by focusing on one aspect of it and using it as a vehicle for understanding how we function as a people. For Bill Wick, that vehicle is the ocean. And one of the most exciting things to happen to the ocean community in a long time is Oregon State University's new maritime studies program.

"It's really a humanities program," Wick explains. With help from the National Endowment for the Humanities, the Office of Sea Grant, and matching funds from the State

Teacher, woodsman, wildlife manager, and "Greatest Living Mole Expert"—Wick has been all these. Clockwise from top, County Agent Wick teaches school kids seashore ecology; displays a chukar partridge as game manager in Nevada; examines an oyster in Oregon tidal pool; mans a "mole booth" at county fair in Tillamook, Oregon; and fells a fir tree near Puget Sound.

of Oregon. Oregon State University is setting up a five-year program to help bridge science and the humanities.

"It all started out with a conference we had in 1974 called 'Steinbeck and the Sea,'" Wick says. "I was very proud of the results because the conference got people thinking about their role in their environment. Through the leadership of Dr. Richard Astra, chairman of the English Department, we've taken community as our central theme for the program. All of us live someplace, you know, but frequently we don't understand community and its relationship to the humanities. Or to science. For humanists, we're trying to move them into an understanding of science, why scientists act as they do, what technology is—and isn't—capable of. And we want to take our technical scientists and give them an opportunity to understand that part of life that breathes and has a soul."

The program, called Marine and Maritime Studies, will involve some nine faculty members from the School of Oceanography and the departments of English, anthropology, psychology, and history and will cover such topics as History of Oceanography, People of Maritime Communities, Literature and the Sea, Maritime History, Development of Maritime Cultures, Human Values and Ocean Technology, and Human Values and the Sea.

In addition to the task of providing leadership, fostering independence, and coordinating the activities of a small army of research scientists, graduate students, marine advisory and cooperative extension agents, students, and the general public, Wick also has a less tangible and in some ways more onerous task of maintaining the integrity of Oregon State's Sea Grant program. "One of the most important things we have going for us at Oregon State University is the recognition in the minds of most people that we are an unbiased source of information," Wick asserts. "If we ever compromise that, we will have destroyed a faith and credibility that has taken years to build. In essence, we have to be careful to be what I call 'neutral advocates': staunchly in support of everything that's positive."

Part of Wick's attempt to maintain the objectivity of OSU's Sea Grant program relates, once again, to the Advisory Service. According to Wick, this is the most difficult job in the whole system. The touchstone of a good advisory agent is his ability to relate to the community he has set out to assist. He has to become a part of the community. "But, he can't become a total part," cautions Wick. "He can't say these are *my* fishermen or *my* marine operators or *my* teachers, or anything else like that. He has to be a part of, but apart from."

As with any developing organism, the Sea Grant College Program at OSU has growing pains. "They're just signs of adolescence," Bill Wick says. "I have two teenaged daughters and I may live through that, too. I think if Sea Grant makes it solidly through the next two or three years—and I have every expectation that it will—it's over the hump. It's been a real challenge to keep the system going long enough to show results and to generate this 'ocean constituency' that I'd love to see develop." □

CONCRETE TO CAMPUS:

By LOUISE A. PURRETT

THE transformation of a worn airfield into one of the nation's chief oceanographic research centers is beginning to show.

At Sand Point in Seattle, a low, flat shelf of land curves out into Lake Washington. The site of a defunct Naval air station, it is paved with cracking, weed-infested concrete and wears the air of desolation of a lost civilization.

Over the coming years, Sand Point will come to life again. The acres of concrete will be replaced by buildings, roads, trees, and lawn. NOAA and the city of Seattle have acquired the airfield. The city plans to convert its 190-acre share into a public park. Plans are being developed to turn NOAA's 116 acres into a campus-like Western Regional Center, bringing together the nine NOAA elements now scattered in crowded facilities at seven locations around Seattle.

Three of those elements are currently installed in offices in a seven-story building on the western shore of Lake Union. Huge, one-room floors are subdivided into a maze of cubbyhole-offices by a network of portable, head-high partitions.

On the main floor is the Northwest Regional Office of the National Marine Fisheries Service. Fisheries researchers and administrators here provide a variety of information and services: statistics on commercial fisheries, loan funds for commercial fishing vessels, a voluntary fish inspection program, and, most recently, assistance in setting up the machinery for administering the new 200-mile limit to U.S. territorial seas.

On the sixth floor is the Northwest Administrative Services Office, which sees to the routine, practical needs of NOAA elements in Seattle, such as maintaining equipment and property, and providing personnel services.

Part of the top floor of the Lake Union building is devoted to the National Weather Service's forecast office, which issues weather and pollution forecasts, and severe weather warnings for the Seattle area and 11 Washington air terminals.

Those NOAA employees lucky to have a view of the lake can look across it to see the white ships operated by another NOAA component, the National Ocean Survey. In a squat building on the eastern shore of the lake is the Survey's Pacific Marine Center, headquarters for upwards of 600 NOAA Corps officers and support staff, and, periodically, the crews of the 10 ships that operate out of Seattle. When they are not carrying researchers into the Gulf of Alaska or the central Pacific—stints that are becoming longer as the ship's seasons are extended to fulfill expanding NOAA responsibilities—they line both sides of two docks on Lake Union.

The Survey's Northwest Regional Calibration Center, one of three in the United States, calibrates oceanographic instruments for Federal, state and municipal agencies, as well as academic institutions and industry. The Center is located in Bellevue, across Lake Washington from Seattle.

Three NOAA components share quarters in a small converted apartment building at the southwest corner of the University of Washington campus. Most of the rooms in this motel-like building are offices for scientists

with the Pacific Marine Environmental Laboratory (one of the Environmental Research Laboratories). Two rooms are being remodeled to house a new oceanographic computer system. Scientists in the laboratory conduct basic and applied research on the marine environment of the Pacific and U.S. coastal areas, and on the interactions between oceans and atmosphere. An office of the Environmental Data Service, and a Seattle branch of the Marine Ecosystems Analysis (MESA) program (another part of the Environmental Research Laboratories), are also located in this building. The MESA program supervises research on the potential effects of deep sea mining and oil drilling and transportation in the Gulf of Alaska and Puget Sound.

The Northwest Fisheries Center will remain on Montlake Blvd., but three of its divisions—the Coastal Zone and Estuarine Division, Marine Fish and Shellfish Division, and Marine Mammals Division—will be moved to Sand Point.

The final occupant of the Sand Point center will be the Fisheries Service's Office of Scientific Publications, which collects manuscripts from Fisheries installations all over the nation, and edits and publishes periodicals and research reports on marine life.

Six of these seven facilities—all but the Fisheries Center on Montlake—are leased, and none provide room for the expansion that is expected for the coming years. Some are already overcrowded. Bringing the separate elements together would have other advantages, such as freer interaction, and cutting the currently high cost of money and time spent traveling and mailing among the scattered offices. Parking is a serious problem everywhere. Employees who do not arrive early enough to get an all-day space may have to leave their desks for 15 minutes later in the morning to move the car out of a two-hour zone.

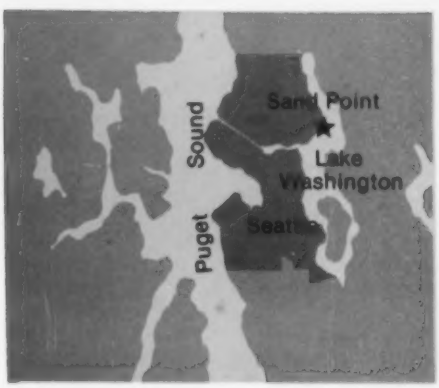
The planned regional center at Sand Point will provide room for present and future activities, laboratories and shops specifically designed for the needs of scientists and technicians, an employee cafeteria and auditorium, four piers and a small boat basin for mooring 12 fishery and oceanographic research vessels, and 950 to 1050 parking spaces.

Actual construction of the new buildings will not begin for at least a year. Meanwhile, the three hangars and an old control tower are being utilized to house the already-expanding NOAA activities. The control tower, standing in lonely isolation on the center of the shelf of land, is currently being refurbished to make offices for researchers with the Pacific Marine Environmental Laboratory and the Deep Ocean Mining Environmental Study, which the laboratory conducts for the MESA program.

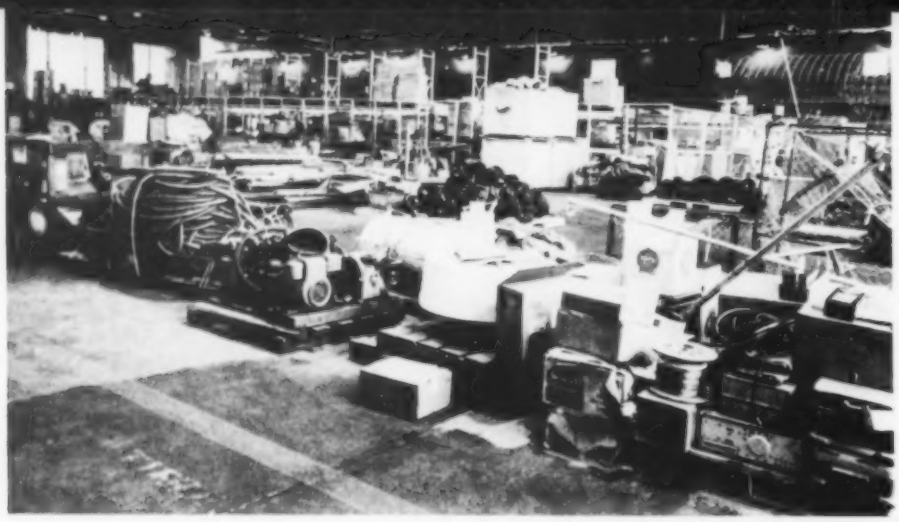
The cavernous hangars are being used as warehouses to store the tons of paraphernalia for oceanographic and fisheries research. On the concrete floor of the huge open space where planes once took shelter, spools of cable, buoys, bright yellow globular floats, ponderous shovel devices for collecting sediment samples, nets, are arranged on racks or in tidy groups and rows.

Around the perimeters of the hangars, and

PROGRESS AT SAND POINT



Acres of concrete at Sand Point, once a Naval air facility, will soon be replaced by trees and shrubs, and old aircraft hangars and control tower—now serving as offices and laboratory buildings—will be replaced by a modern research building.



Cavernous hangar spaces (above) now serve as warehousing for the tools of oceanographic and fisheries research, while workmen refurbish the old control tower (left) for scientific offices. Spiral staircase (below) leads to top of former Navy control tower.

in a two-story building-within-a-building, are biology, chemistry, and electronics laboratories and more offices. At present, Pacific Marine Environmental Laboratory and National Fisheries Service scientists, including the Marine Mammal Division, have moved in. Also in the hangars are shops where the equipment is repaired and refurbished before being sent out into the field again.

These are only interim facilities. The first of the new buildings will be the operations building. The Northwest Administrative Services Office, the National Weather Service, the Northwest Regional Office of Fisheries, and the Pacific Marine Center, will move into the operations building. Along the northern shore of Sand Point will be the ships' piers.

Large enclosed work areas will replace the hangars. Such space is necessary for setting up oceanographic experiments. For example, cables that will hold current meters or sediment samplers must be laid out and measured so that they will be just long enough to reach a desired depth.

The Weather Service's training facility is to be moved from Kansas City into a new educational center at Sand Point. In addition to classes for Weather Service forecasters, the center will provide space for other types of government and NOAA-related courses for employees from all divisions of NOAA in Seattle.

The largest building will be a research building. Roughly half of the building's planned 115,000 square feet will accommodate the Pacific Marine Environmental Laboratory and the Marine Ecosystems Analysis program's Seattle office, joining the people now scattered among the tower, hangars, and University of Washington campus. The Fisheries Service research divisions will occupy the rest.

In all, 866 persons will be working at NOAA's Western Regional Center on Sand Point. Another 700 will be using Sand Point when the NOAA vessels are in port.

A reception center near the main entrance to the NOAA grounds is also planned, to provide main gate services, dispense information on NOAA activities, and arrange tours.

The transition will be slow and complex. A Sand Point Project Office, working closely with the Northwest Administrative Services Office, has been set up to plan the new facility and coordinate the move. Architects are now working on the basic concepts—the general layout and "feel"—for the Regional Center. This stage of planning is scheduled for completion this month. Then the actual design of the facilities can begin.

Throughout planning and construction, the emphasis will be on creating a complex that harmonizes with the environment. The buildings will be as unobtrusive as possible, and spread out, with curving streets joining them. Trees will shield parking areas from view by homeowners in the nearby residential areas. The NOAA center will be separated from the city park by a natural division, such as a gently curving ridge or gully planted with trees and shrubs.

From the start, the concerns and ideas of the community have been included in planning. A community liaison committee, set up under the auspices of the mayor's office, meets regularly with the Sand Point Project Office.

In December, for example, the committee was invited to meet aboard the NOAA ship Discoverer, moored on Lake Union. The architectural firm selected to design the new Western Regional Center presented plans for four different concepts being considered. Some were structured with buildings in a line, some informal, like a college campus. Possibilities—such as using the earth dredged out to make a lagoon to build up a slightly elevated spit of land projecting into the lake from which visitors to the park can view the entire complex—were discussed. Representatives from NOAA, including Deputy Assistant Administrator Robert Carnahan and Dale Gough, Director of the Northwest Administrative Services Office, listened and responded as committee members voiced some of the concerns of the community: Will NOAA's electronic activities affect television reception? Will traffic along Sand Point Way become congested? What provision will be made for visitors?

To make the complex as unobtrusive as possible, and preserve the scenery of the lake front, NOAA has agreed not to build within 200 feet of the shoreline, and to limit the height of buildings to under three stories. The actual design of buildings has not begun, but the architect intends to make them blend with the natural surroundings as far as possible. Because of the Federal government's requirements for energy efficiency, they may even be partially underground, or topped with a layer of earth. For residents of the neighborhoods on the two ridges overlooking the point, "it might be an interesting thing to see—or not see," comments one of the architects.

There are more NOAA people in Seattle than anywhere else outside the Washington, D.C. area. This proximity of so many NOAA elements, says Dr. John Apel, Director of the Pacific Marine Environmental Laboratory, "has had a tremendously unifying influence." The different divisions—Fisheries, the Weather Service, the environmental researchers, and Ocean Survey—work closely together. It will take some years, but eventually NOAA's scattered Seattle operations will be brought together physically as well as in spirit. □

The Hirshhorn home is located over the original site of the 1833 Round Hill (Conn.) triangulation station.

A Bicentennial gesture

1833 REVISITED

AS A CHILD, I was always interested in mechanics . . . fixing the iron, the toaster, and the lamps around the house—building and repairing things." But what Leonard Samuel Baker, of Clarksdale, Miss., really wanted to do was to build bridges, to become a civil engineer.

Although the only bridges that Capt. Baker built were those of youthful dreams, his dedication in later years to the work of the National Geodetic Survey as its Director has helped make that organization a leader in world geodesy.

On July 14, 1972, Capt. Baker was appointed Director of the National Geodetic Survey, a component of NOAA's National Ocean Survey. He supervises approximately 350 people in Rockville, Md., Corbin, Va., Gaithersburg, Md., Ukiah, Calif., and Anchorage, Alaska, and field parties conducting geodetic surveys throughout the United States.

The NOAA agency maintains national geodetic networks and exercises government-wide leadership in assuring coordinated planning and execution of surveys performed by contributing organizations. It conducts satellite geodesy operations, gravimetric and astronomic surveys and investigations of the movements of the earth's crust.

It was late December 1976 when Capt. Baker visited Round Hill, Conn., and Tarrytown, N.Y., for the final NOS commemorative events of the Bicentennial Year—to erect two plaques in observance of the oldest geodetic triangulation stations in America. At Round Hill, standing in the great hall of a privately owned mansion before a group of surveyors, engineers and other guests, Baker summed up his feeling about the Survey.

"We're the oldest scientific organization in the Federal government," he said. "We fostered the National Bureau of Standards organization which was the Division of Weights and Measures that our first Director, Professor Hassler, had also established.

"The work that Hassler did so many years ago," he continued, "is still being used today just as though it was done yesterday. The Federal government has reaped a tremendous benefit from everything that Hassler did."

Ferdinand R. Hassler was appointed by President Jefferson in 1807 as the first Superintendent of a new bureau authorized to survey the coasts of the United States "in which shall be designated the islands and shoals and places of anchorage. . ." Hassler, a Swiss-born geodesist and scientist, received $25,000 from the government, but he had neither materials, equipment nor staff. The War of 1812 intervened during a trip to Europe to obtain surveying equipment, and it was not until 1817 that field work was started near New York City. Within two years, however, work had to be suspended when Hassler's bureau was moved from one department into another because of Congressional charges that the work was lagging. Hassler was excluded, and it was not until 1832 that the survey was resumed with Hassler again in charge.

In May of 1833, Hassler, who was then 63 years old, set out through New York and Connecticut to complete the east coast survey that had lain dormant for 15 years. He reached Round Hill, Conn., on July 13, 1833, where he established one of the first triangulation stations in America.

The Round Hill marker or station, which serves as part of the mathematical skeleton for the nation's maps, was buried below the surface of the ground near the center of a meadow crowning a hill enclosed with stone and rail fences. It was located 71 feet, 8-inches north of a poplar tree; 63 feet, 5-inches west of another poplar. In 1866, the marker

was replaced and two years later checked and verified. But in 1882 a search for the Round Hill marker proved unsuccessful—the trees had disappeared and no marks on the stone walls could be found.

Although described in a 1908 report as being in cultivated land on the summit of a prominent hill ¼ miles east of the village of Round Hill, all reference marks for the station had disappeared. In 1936, the approximate location of the Round Hill station was again found by computing the geographic position of two stations nearby and comparing the results. Upon digging at this point, the 1866 marker—a cast-iron cone set inside a piece of 15-inch tile pipe—was uncovered at a depth of about 12 inches below the surface. A year later, when the site was being cleared for the construction of a home, a new station had to be established.

The original marker—placed on the hill by Hassler 143 years ago and covered with oyster shells from Long Island Sound, recovered in 1866, and then disappeared until 1936—is now represented by a bronze disk embedded on the hearth of the great hall fireplace in the home of Joseph H. Hirshhorn, a financier and art collector.

Mr. Hirshhorn stood across from Capt. Baker who spoke of Hassler and the National Geodetic Survey. Olga Hirshhorn, Mr. Hirshhorn's wife, Francis A. Paul, president of the Connecticut Association of Land Surveyors, and Rupert Vernon, first selectmen of the Town of Greenwich, were among the guests invited to attend the ceremony.

Capt. Baker presented a model of the 3.6-inch-wide bronze disk used by the NGS to mark triangulation stations where surveyors determine the site's longitude and latitude.

Mr. Hirshhorn smiled as he examined the disk. "I finally got something for nothing," said the 77-year-old multimillionaire, who 11 years ago donated his collection of paintings by Jackson Pollock, Stuart Dave, and Thomas Eakins to name only a few, and sculptures by Henry Moore, Picasso, Marini and many others—a collection of 5,600 pieces—to the United States, with a gift of $1,000,000 for housing the collection in the Nation's capital.

"As a geodesist," said Capt. Baker, "this could be considered, well, holy ground. From this meager beginning we now have 200,000 such stations throughout the country."

And it was, indeed, a meager beginning. Hassler continually found himself on the defensive concerning the time he was taking to complete the survey. His persistence, however, in demanding the finest equipment and the most knowledgeable assistants, outlasted the politically motivated attacks against him and the survey.

Hassler's field party of 1833 consisted of four assistants who were detailed from the army and navy, two 'second' assistants, 15 to 27 'laboring men' and an enormous custom built carriage that carried the more than 100 pounds of measuring instruments including his 24-inch theodolite, which he had designed himself. Another conveyance, a Jersey wagon, held the tents, and the necessary tools for preparing stations, and placing signals. Horses and harnesses were obtained, the "first strong and sure, the second simple but strong." For his services, Hassler received $3,000 a year and a $1,500 personal expense account. Two of his four assistants were paid $2 per diem; the other two received $1. The remuneration for the services of the 'second' assistants and the 15 to 27 'laboring men' is not recorded.

When the stone mansion was built over the Round Hill site in 1936, the Federal government established a new 'working' marker out on the lawn. Mrs. Hirshhorn recalled that once some surveyors came and erected a tower over the marker and spent several weeks making measurements. Otherwise, she said, having a geodetic marker on your property is merely a good conversation piece.

After the ceremony in the house, the Hirshhorns, Capt. Baker and guests bundled up and went down the snow-covered hill to a stone wall along the road where workmen had set the heavy bronze plaque against the wall.

"Take the cover off, Dave," said the superintendent after the group had gathered at the spot. While photographers took pictures and reporters interviewed the guests, the plaque was unveiled.

"God bless America," said Mr. Hirshhorn, "and don't forget that."

Capt. Baker thanked the Hirshhorns and the guests.

The snow began to fall and, after the crowd

ABOUT 100 METERS WEST OF THIS LOCATION LIES
ONE OF THE OLDEST TRIANGULATION STATIONS
IN AMERICA
ROUND HILL 1833
THIS PLAQUE IS ESTABLISHED
AS A BICENTENNIAL COMMEMORATION
THROUGH THE COOPERATION OF
JOSEPH H. HIRSHHORN
GREENWICH BICENTENNIAL COMMISSION
CONNECTICUT ASSOCIATION OF
LAND SURVEYORS INCORPORATED
THE NATIONAL GEODETIC SURVEY OF
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
AMERICAN CONGRESS ON SURVEYING AND MAPPING
1976

Capt. Baker presents Mr. Hirshhorn a model of the bronze disk (left) used by Hassler to mark survey stations in 1833. Attending the ceremony at the Hirshhorn estate (above) are from left to right: Rubert Vernon, First Selectman, Town of Greenwich; Francis A. Paul, Pres., Conn. Assoc. of Land Surveyors; Mr. Hirshhorn; Capt. Baker; Olga Hirshhorn; Paul Hallisey, Conn. Assn. of Land Surveyors; and Allan S. Devaul, S. E. Minor Co. Surveyors.

The National Ocean Survey's Buttermilk Bicentennial commemorative plaque is being installed on this bridge near Tarrytown, N.Y.

had trudged back up the hill, it quietly obliterated their footprints.

Hassler had spent more than 13 days establishing the Round Hill Station, more than twice the time required if the weather had been favorable. On July 18, his field party moved about 13 miles northeast to Bald Hill, near Wilton, Conn., where on July 24 the party was hit by "the severest gale, with hail and rain. . ."

"All our tents except one," writes Hassler, "were fully blown away; three barometers that were in one of them were entirely broken." It took the entire party to secure the one tent in which the telescope from his theodolite had been secured.

In a letter dated the 27th of July in which Hassler describes the storm, he writes that "not three hours before (the storm), I had been bled, on account of the severe pain in my breast, occasioned by a fall upon a rock three days before, which had been so severe as to deprive me of speech, and made me apprehend some internal lesion. The severe drenching and exertions which the storm brought upon me, together with all the other, are perhaps the cause that I am still suffering under the effect of the fall, particularly in stooping for observations."

Until Hassler's field party ceased operations on the northern side of Long Island Sound that December, its efforts were constantly hampered by frequent rains and fogs which impeded "the visibility of any signals, and even the island itself."

Established under Hassler's direct supervision in June 1833, the "Buttermilk" station in New York is one of America's first 'first-order' stations—meaning that it is part of the main triangulation (with sides from 10 to 50 miles long) that determines large distances with greater accuracy than the secondary triangulations which form the basis of topographic surveys and include details of the ground, outlines of the coast or shore, courses of bays, rivers, and roads. Other 'first-order' stations established by Hassler's field party during 1833 include Mount Carmel near New Haven, Conn., Tashua near Bridgeport, Conn., and West Hill on Long Island.

Today, the Buttermilk Station is unique because it is one of the few 'first-order' markers that has remained undisturbed. Its site is on the Pocantico Hills estate of the Rockefellers nestled above Tarrytown, N.Y., among rolling hills overlooking the Hudson River. Although part of the estate, begun by the late John D. Rockefeller Sr. in 1893, was designated a National Historic Landmark in May 1976, none of its 3,500-acres is open to the public. The estate is operated by the Greenrock Corporation, which is located within the walled compound at the estate's entrance.

Capt. Baker arrived at the Greenrock Administration building, followed by a group of engineers representing the American Congress on Surveying and Mapping, which he was serving as president. The ACSM is a national organization of more than 7000 surveyors and cartographers.

A month before the scheduled presentation of the commemorative plaque, a spokesman for the Greenrock Corporation informed Capt. Baker that it would not be possible to install the plaque on or near the Buttermilk station site. Another site had been selected—a stone bridge over a carriage path about 800 meters east of the original site.

Situated on the southern summit of Buttermilk Hill, the original station was marked by drilling a hole of 2-1/2 inches in diameter and 10 inches deep into rock which supported a leg of one of Hassler's instrument stands. Since 1833, the site had been checked at least nine times. The 1932 inspection reported the drilled hole had been filled with cement with a 3/4-inch iron pipe in the center. The station was described as being surrounded by trees and brush about 25 feet high. In the most recent report dated 1966, the station and all the marks were "recovered and found to be in good condition."

The ceremony at the carriage bridge before representatives from the Westchester-Putnam Association of Professional Land Surveyors, Inc., and the American Congress on Surveying and Mapping, was brief.

"To those involved in surveying," said Capt. Baker, "this is where the master started—143 years ago. We are very proud of the fact that the National Geodetic Survey has kept his work going; and we present this commemorative plaque as a tribute to the fortitude of the people who set it up."

After the plaque, resting on a stand impaled in the snow, was unveiled, the small crowd returned to their cars and drove down the road to the Greenrock Corporation compound where it was decided to visit Union Church, a non-denominational church just outside the main gate of the estate. All of the church's stained-glass windows—one by Henri Matisse and nine by Marc Chagall—were commissioned by the Rockefeller family, several in memory of family members. The President had attended a Thanksgiving service there a month before.

Standing outside the church, Capt. Baker recalled that his first task as the Director of the National Geodetic Survey was to make a concentrated study of geodetic control during which he traveled around the country interviewing private sectors of geodetic control. He found that the Federal government was not the main user of these controls, and that the NGS should work more closely with the private sector. To this end, he initiated an intensified program to provide information about data that was available.

"People were anxious to learn more," Baker said. "At the same time surveying instruments were becoming cheaper, smaller, more compact. Surveyors were anxious to learn the ways of the National Geodetic Survey, the new instrumentation, and technology."

Baker also increased the NGS educational program and encouraged his surveyors to go to night school. "Today," he said, "our advanced academic training and our new hires have resulted in the fact that over 35 percent of our professionals have advanced degrees."

Baker said that five years ago, he set a goal that NGS would recapture its position as leader in world geodesy, a position that had been undisputed during the Hassler era. "I think we have achieved that goal," he said as he walked into the church.

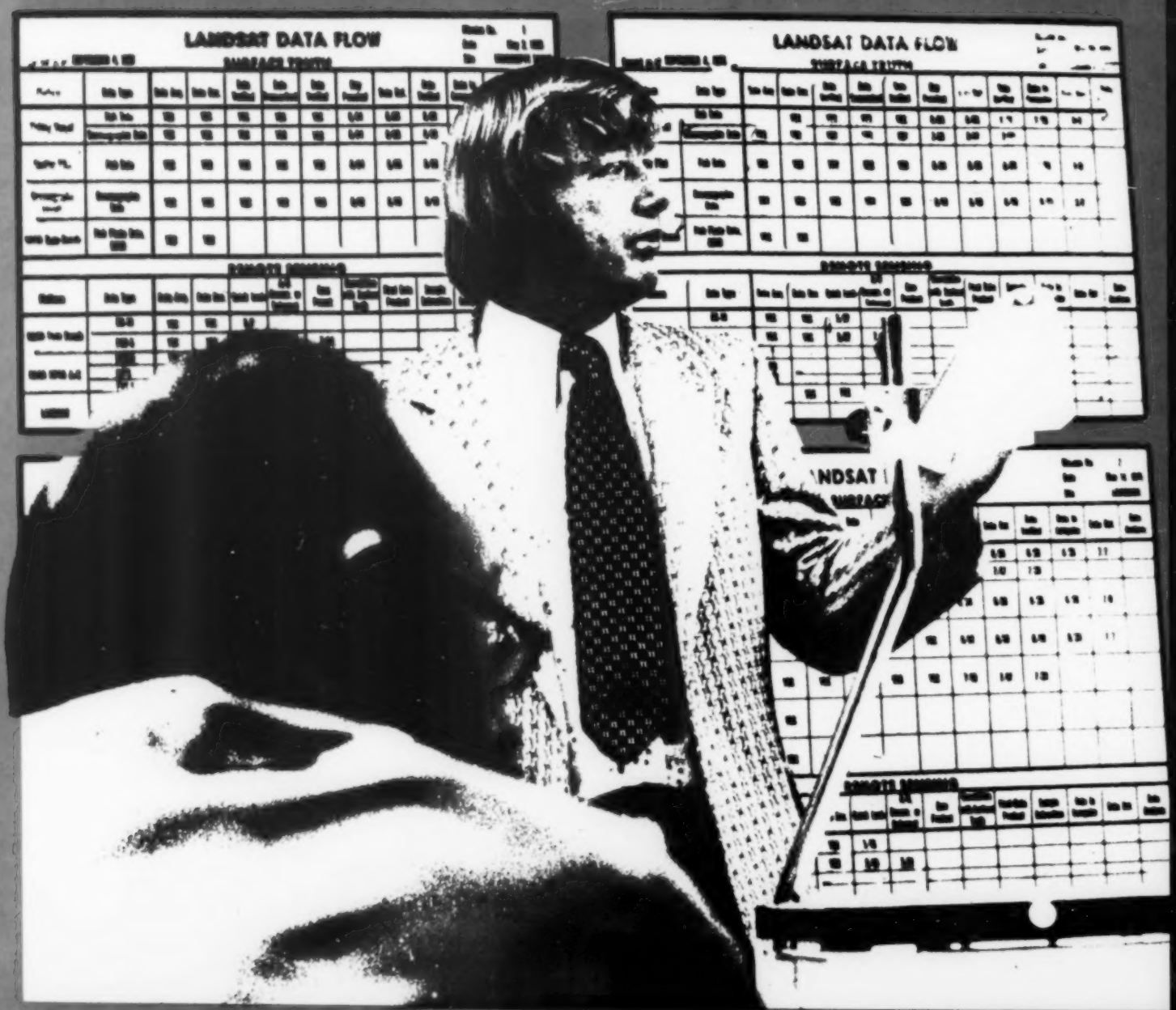
After the presentation of the bicentennial plaque commemorating the work of Hassler at Round Hill the day before, Baker had said he wished he could be around for the Nation's Tricentennial.

"You might come back," said Mr. Hirshhorn. And then, for the tenth or twelfth time that day, he exclaimed, "God bless America!" □

From the sea bottom to space

Fisheries Engineers Explore New Frontiers

By GERALD D. HILL, JR.



WAYS of catching fish have fired the human imagination since prehistoric times when man discovered fish were for eating. Long past spearing days now, we are moving into a technology which reaches from the depths of the ocean floor with the prospect of developing an electric field to flush nocturnal shrimp into fishermen's nets during more convenient working times, into space with the use of satellites pinpointing fish locations.

By studying the possible applications of industrial and space engineering technology, a new breed of scientists are developing techniques which will augment the management, harvesting, and protection of U.S. fishing resources.

This group of fishery engineers was created within the Southeast Fisheries Center of the National Marine Fisheries Service to apply and monitor scientific techniques which could be used in the collecting, processing, and managing of information required to make fisheries management decisions.

The man guiding the activities of the National Fisheries Engineering Laboratory, Dr. Andrew Kemmerer, describes a wide spectrum of research projects. "We deal in remote sensing systems to assess the resources that are available to the fishermen and develop sampling systems and fishing gear for latent species. Our latest ongoing experiment with satellites leads us to believe that we can predict with 90 percent assurance the location of certain species of fish schools."

The successful project he refers to is the LANDSAT Menhaden and Thread Herring Investigation, initiated in 1975 to explore the feasibility of using satellite data for assessing fisheries resources in the northern Gulf of Mexico. Working closely with boats, planes, and crews from member companies of the National Fish Meal and Oil Association and co-investigators from NASA's Earth Resources Laboratory, the lab scientists determined that there are relationships between the distribution of menhaden and measurements from space.

"The sensors on LANDSAT satellite measure the color of the earth's surface," says Ken Savastano, chief of data management for the fisheries lab. "From the color we can deduce the turbidity (clearness of the water) and chlorophyll of the water. Aircraft measurements of infrared and microwave radiation can be used to measure salinity because of the effect of temperature and dissolved salt on the dielectrical properties of the water."

Scientists know that environmental factors influence the distribution of fish and have surmised that by measuring these factors they should be able to predict the location of fish. Satellites, unfortunately, do not have sufficient resolution to detect fish directly.

In the test, water color data measured by the sensor aboard LANDSAT for waters where fish were being caught by fishing boats were used to develop a computer model. This model was then used to examine the color characteristics of all waters observed by the satellite in the same general geographical area.

"When the satellite found an area with color characteristics similar to those where fish were caught, then we knew from previous analysis that there was a high probability that fish would be found in the area," said Savastano.

To show how satellite data might be used to help fishermen, a special analysis of LANDSAT data in near real time was done last summer. In the late morning hours of July 19, 1976, LANDSAT I passed over a selected study area in the northern Gulf of Mexico sending electromagnetic multispectral scanner data to a receiving station at the Goddard Space Flight Center in Greenbelt, Maryland.

At the receiving station, investigators reviewed the data in image form prior to storing it on four large magnetic tapes. The tapes were then hand-carried to the NASA Earth Resources Laboratory in Slidell, La., where another team of scientists further processed the satellite's information, geographically referenced it, and analyzed it for high probability menhaden areas. At approximately 7:15 a.m. on July 20, less than 21 hours after the satellite began viewing the study area, the first telephone calls were made to inform spotter pilots and vessel captains of the probable locations for menhaden so that they could compare and check their vessel findings with the scientific predictions as an experimental control. Reports from the fishing industry indicate that the satellite did its job well.

"While the test was a success, considerably more work will be required before an operational satellite system can be made available for application to fishery problems," says Dr. Kemmerer. "At best it would take three to five years before such a system could become operational. Other coastal, and perhaps oceanic, species will have to be considered and additional investigations may be required. Special computer programs and facilities will have to be developed. The concept, however, has been demonstrated and that should make future efforts easier."

The Fisheries Engineering Laboratory is on the National Aeronautics and Space Administration's sprawling National Space Technology Laboratories (NSTL) just north of Bay St. Louis, Mississippi. NSTL is situated on 13,424 acres of flat, pine-covered land and surrounded by another 128,526 acres of uninhabited land. The area was established in the mid-60's to test the engines for the rockets for the Apollo space craft; its size was necessary to protect the residents from the noise of the rocket engine testing.

Elements of the National Oceanic and Atmospheric Administration, Environmental Protection Agency, the Departments of the Interior, Transportation, and Defense as well as Mississippi and Louisiana State Governments and universities enhance NSTL's technical and scientific community by sharing, interchanging, and using individual research developments.

"NMFS has a well-established program of biological sampling and research; however, sufficient engineering capability has not always been available to apply engineering talents and principles to fishery problems when technology is found to be a major constraint to achieving our goals," says Dr. Kemmerer. "Our job is to satisfy the technological needs of the Fisheries Service, promote technological advancements in fisheries management and use, and apply engineering expertise to fishery problems when needed.

"We do this by developing sampling, monitoring, and tracking systems to increase data return, coverage, and accuracy; developing fishing gear and tactics to efficiently harvest latent and underutilized fishery resources, conserve non-target species, and reduce damage to marine habitats; and developing data management systems and techniques for efficient data storage, retrieval, display, and analysis."

Other applications of satellite technology are being investigated by the lab. Two other projects underway are the use of satellites to track porpoises in the eastern tropical Pacific Ocean, and for fishing vessel surveillance.

RUFAS II, developed by NMFS and the Mississippi State Sea Grant program, is used for ocean bottom surveys. (Facing page)Dr. Andrew Kemmerer, Director of the National Fisheries Engineering Laboratory, discusses data obtained from the LANDSAT menhaden and thread herring investigation.

The National Marine Fisheries Service assumed responsibility for enforcing the Marine Mammal Protection Act when it became law in 1972.

"Particular data are lacking concerning the activities, movements, descriptions, age, sex, and growth of porpoise stocks. Conventional tracking programs appear to be inadequate in providing stock movements," Glade Woods, Deputy Director of the engineering lab, says.

At this stage the scientists are identifying requirements for a satellite-linked porpoise tracking system. From these requirements they will design and procure prototype transmitter units which can be attached to porpoises for testing and evaluation.

Workshops have been held with porpoise and marine mammal tracking investigators from the NMFS, NOAA, NASA, Navy, Fish and Wildlife Service, Porpoise Rescue Foundation, Marine Mammal Commission, and from the academia. From these workshops, preliminary systems requirements were identified for the satellite-linked tracking system. Cooperative agreements will be established with participants of the proposed study to design, construct, test, and evaluate such a system.

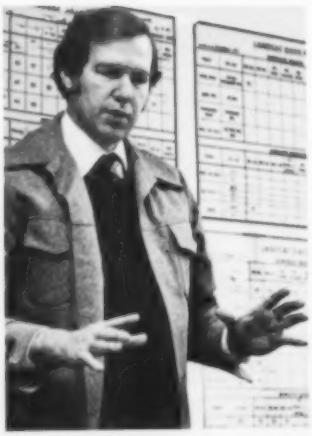
"The National Data Buoy Office will take the lead in the design and procurement of two to three prototype transmitters," says Woods. "The test of these prototype transmitters will be carried out in cooperation with the Naval Undersea Center, San Diego, California. Prototypes will be controlled-tested on captive porpoises for approximately 30 days. Data will be transmitted from the attached transmitter through the NIMBUS 6 satellite to NASA's Goddard Space Flight Center for the test. Depending on the results of the test, design modifications will be made and field experiments carried out for development of an operational tracking system."

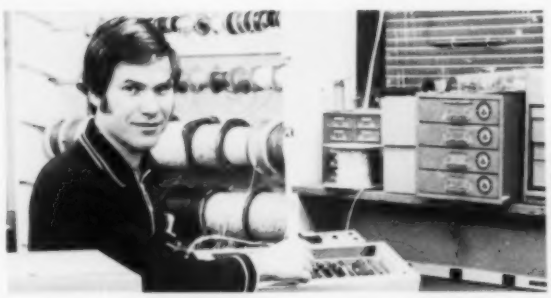
The Fishery Conservation and Management Act of 1976 has given the National Marine Fisheries Service a major role in implementing and enforcing regulations governing the 200-mile zone off the coasts of the United States.

One of the major aspects of this new responsibility, which is shared with the Coast Guard, will be control of the foreign vessels permitted to fish within the zone.

"We conducted a test off Georges Banks in March 1976 to determine the feasibility of using satellite-supported surveillance systems for monitoring fishing vessels," says Dr. E. A. Stevenson, project engineer for the test.

"This was a joint test involving the Coast Guard, NASA, and the National Marine Fisheries Service," says Dr. Stevenson. "We made two flights using four aircraft over the area in coordination with three strategically located Coast Guard cutters. The cutters were used to coordinate the flights, gather information on the ships in the area and serve as geographical references. A C-46 aircraft equipped with a radar system similar to the one scheduled for launch aboard the SEASAT-A satellite in 1978 flew at two different altitudes to test the radar. A Coast Guard C-130 aircraft took aerial photos, and a Coast Guard helicopter and another Coast Guard aircraft worked with the cutters to identify each fishing vessel sighted," Dr. Stevenson continues.





Photos: G.D. Hill, Jr.

Participants in fisheries engineering advances are (clockwise from top left) Glade Woods and Dr. E. A. Stevenson of the Bay St. Louis laboratory, Will Seidel and Robbin Riley of the Pascagoula laboratory, Ken Savastano of Bay St. Louis, and Ken Fuller of the NASA Earth Resources Group

"We made a total of 20 radar runs during the test," says Dr. Stevenson. "We were able to distinguish 38 vessel images from the radar. Of these, we were very confident that we could identify 22 of the ships and reasonable confident of positive identification of three others. We were not sure of the identification of eight others and five could not be identified.

"The initial test was encouraging; however, we are just beginning and much has to be done before we have a fool-proof system," says Dr. Stevenson. "We believe, however, that sharp, distinct radar images should permit vessels to be classified by size. In addition, it may be possible to determine class information from power scan measurements, and it is conceivable that the arrangement of ship superstructures, raised decks, and rigging may be discernible from the data we get from the radar.

"We think we have made a good start towards demonstrating a satellite surveillance system. The results of these tests should give us the limitations of the radar system, how the environment affected the results, and aid in establishing design parameters for a theoretical surveillance system."

Other projects being conducted by the Fishery Engineers are just as important, though probably not as exotic, as the ones using satellites. One of these projects resembles the use of a spacecraft but it is used at the other extreme—beneath the sea.

"The Remote Underwater Fisheries Assessment System (RUFAS-I) is used to survey the bottom to determine if certain species of shellfish are available to be harvested in

commercial quantities," says Will Seidel, Manager of the Harvesting Technology Group at Pascagoula, Mississippi. "The vehicle is designed to be towed behind a research vessel and 'fly' several feet off the bottom. A scientist on board the boat uses acoustical signals and underwater television cameras to direct the flight of the craft," says Seidel.

RUFAS-I is approximately nine feet long, six feet wide, weighs about 1,000 pounds, and is towed at about two to three knots down to depths of 50 fathoms. It has been used to locate scallop beds off the east coast of Florida, and the information obtained by the survey was used extensively by commercial fishermen to harvest the scallops.

"Since scallop beds generally run north and south, RUFAS-I is towed on east-west tracks that generally follow navigation lines in the area. This enables us to be rather sure when beds are crossed although occasionally north-south tracks are followed when a heavy scallop concentration is found," says Seidel. "Often we return to areas of heavy concentration to sample with dredges to determine the size, meat count, and verify scallop abundance. From information obtained with RUFAS-I and verified by the dredging, profiles of those areas believed to represent a good source of scallops are developed. These profiles are identified on charts showing heavy, light, or medium concentrations of scallops which are then made available to fishermen. With this information, a fisherman can decide what areas he wants to fish. It takes three to four weeks after the survey to get the information to the fishermen; however, the scallops don't move around very rapidly. Since they depend on the currents, fishermen know that they can probably find the scallop beds within a mile or two of where we located them," says Seidel.

Another larger, more sophisticated vehicle, RUFAS-II, is being developed to continue the work done by the original vehicle. RUFAS-II is larger and heavier and has the capability of "flying" along the bottom or a set distance from the bottom without having to be controlled manually from the towing ship. Like RUFAS-I, it has underwater remote television cameras and can take still photos. The major difference between the two vehicles relates to a more advanced guidance system and an ability to go down to 400 fathoms.

"We are also expanding the area in which we will use the vehicle," says Seidel. "In the past we have been concentrating on the waters in the southeast and Gulf of Mexico, but now we are considering a proposal to survey crab populations in the Bering Sea, and we hope to do more surveys in deep water."

Research also is involved in less exotic projects but nevertheless of equal importance. The development of specialized shrimp trawls is an example.

"A project has been started to develop a technical alternative to significant shrimp fleet discard problems in the Gulf of Mexico. This project is a harvesting gear development effort aimed at eliminating the non-target species catch in shrimp trawls," says Seidel. "Because the fishing grounds of the shrimp and groundfish fleet are overlapping, the large incidental catches and destruction of fish and other animals by the shrimp fleet has become a major concern."

The shrimp fleet captures from 8-20 pounds of unwanted fish per pound of shrimp caught. These fish are considered "trash" by the shrimp fleet and are discarded overboard. This capture of "trash" fish is of serious concern to the groundfish fishery, while the capture of unwanted fish increases sorting labor costs of the shrimp fleet and creates a serious catch handling problem for the small boat operator.

The objective of the project is to develop a new type of shrimp net to effectively separate shrimp from the unwanted fish in the catch, and release the latter back into the sea unharmed. The investigation is expected to develop a separator trawl to achieve a target goal reduction of 90 percent of the fish and shellfish with a maximum shrimp loss of 10 percent. Effectiveness of the separator trawl will be evaluated and demonstrated for different conditions of shrimp size, and size and concentrations of fish and other catch components.

"Based upon SCUBA diver observation of shrimp and fish behavior in shrimp trawls, we designed an experimental net for the southeast shrimp fishery," Seidel says. "Three preliminary cruises for diver observations and comparative fishing trials were made and several proposed designs of the separator trawl were evaluated to determine which had the most potential for development into prototype configuration. A laboratory study was also conducted to determine the best separator panel mesh configurations for maximum shrimp and fish separation and a prototype separator trawl was designed," says Seidel.

"We have conducted evaluation cruises of the prototype separator trawl and are encouraged by the results. Sponges and crabs were eliminated and good progress was made in the reduction of the fish portions of the catch. Perhaps most important at this step of development, is that the loss of shrimp was maintained at 10–15 percent in a 40-foot net."

Immediately surrounding many commercial shrimp grounds, as well as in potential new areas, commercial quantities of shrimp are certain to exist, but harvest is impossible with conventional fishing gear because of rough bottom conditions. Small coral, loggerhead sponge, and moderately rocky bottoms in these areas prevent the use of conventional shrimp trawls. Since commercial quantities of shrimp are harvested from smooth bottom areas in and near the rougher bottom areas, the restricted bottoms probably support an unutilized shrimp resource. "We are developing a trawling system which will allow harvest of the shrimp resource in moderately rough bottom areas," says John Watson, project leader at Pascagoula.

Electrical shrimp harvesting technology developed during earlier experiments will be adapted to a new shrimp harvesting system for rough bottom areas. The shrimp trawl itself will be designed to operate above bottom at a height sufficient to pass over bottom hazards. A pulse generator, its electrode array, and the electrical field configuration will be used to force shrimp from the bottom to a vertical height sufficient for capture in a trailing shrimp trawl.

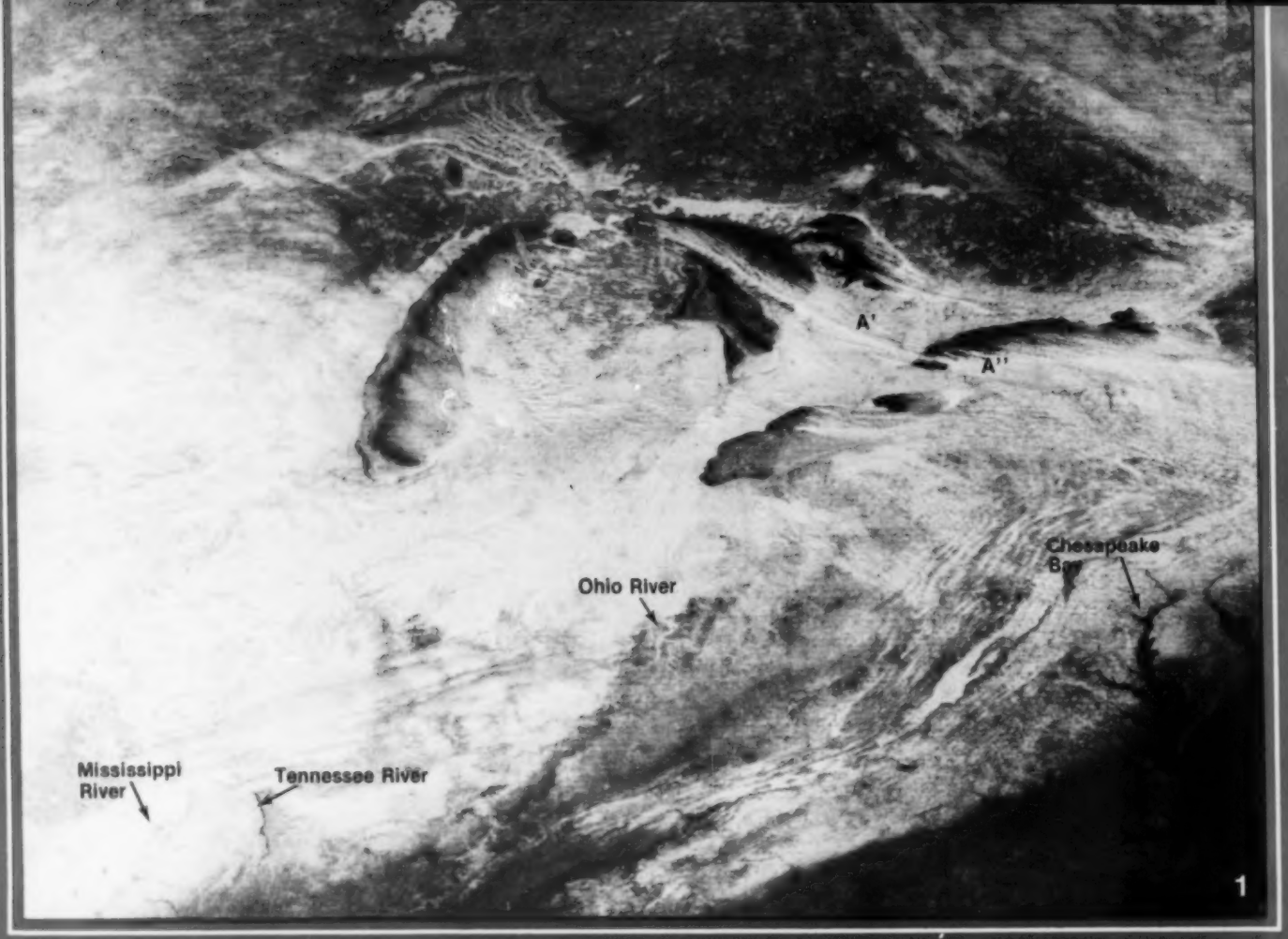
"We will field test and evaluate the system aboard fisheries research vessels to arrive at the best design for an off-bottom shrimp harvesting trawl," says Watson. The system's effectiveness as a harvesting and as a resource assessment system will be evaluated. If the design is effective in accomplishing harvest of shrimp from rough bottom areas, the system will be introduced into NMFS survey and assessment tasks and demonstrated to the commercial shrimp industry for their use." Seidel says that behavioral experiments have been completed with shrimp to determine electrical field characteristics necessary to properly control and force shrimp from the sea bottom to a height of approximately four feet above the bottom. An electrode array has been designed and SCUBA diver evaluated under actual fishing conditions. A specialized set of shrimp trawl doors has been acquired, and a prototype shrimp trawl has been designed and constructed for future field trial evaluations.

A more recent engineering project is the design of a shrimp trawl that will prevent sea turtles from becoming entangled in the nets and drowning.

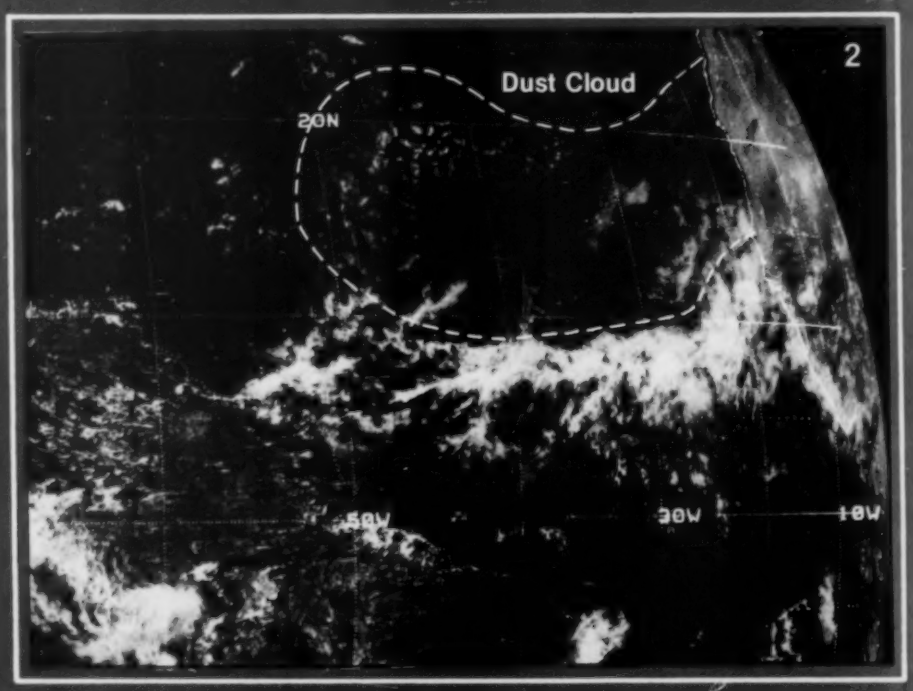
Significant decreases in most marine turtle populations stem from a variety of man's activities including the exploitation of turtle products and extensive coastline development resulting in habitat alterations detrimental to turtle nesting. The declining numbers of turtles has resulted in three marine turtles being placed on the Endangered Species List, and three other species have been proposed for the Threatened Species List.

Recent interest in the capture and occasional drowning of sea turtles in shrimp trawls has generated a potentially serious problem for the shrimp industry, according to Charles McVea, project leader. "There is enough circumstantial evidence to suggest that a significant number of turtles may be killed by fishing activities. To identify a technical alternative for this problem, a project has been established to develop a shrimp trawl which will eliminate the capture of sea turtles," he said.

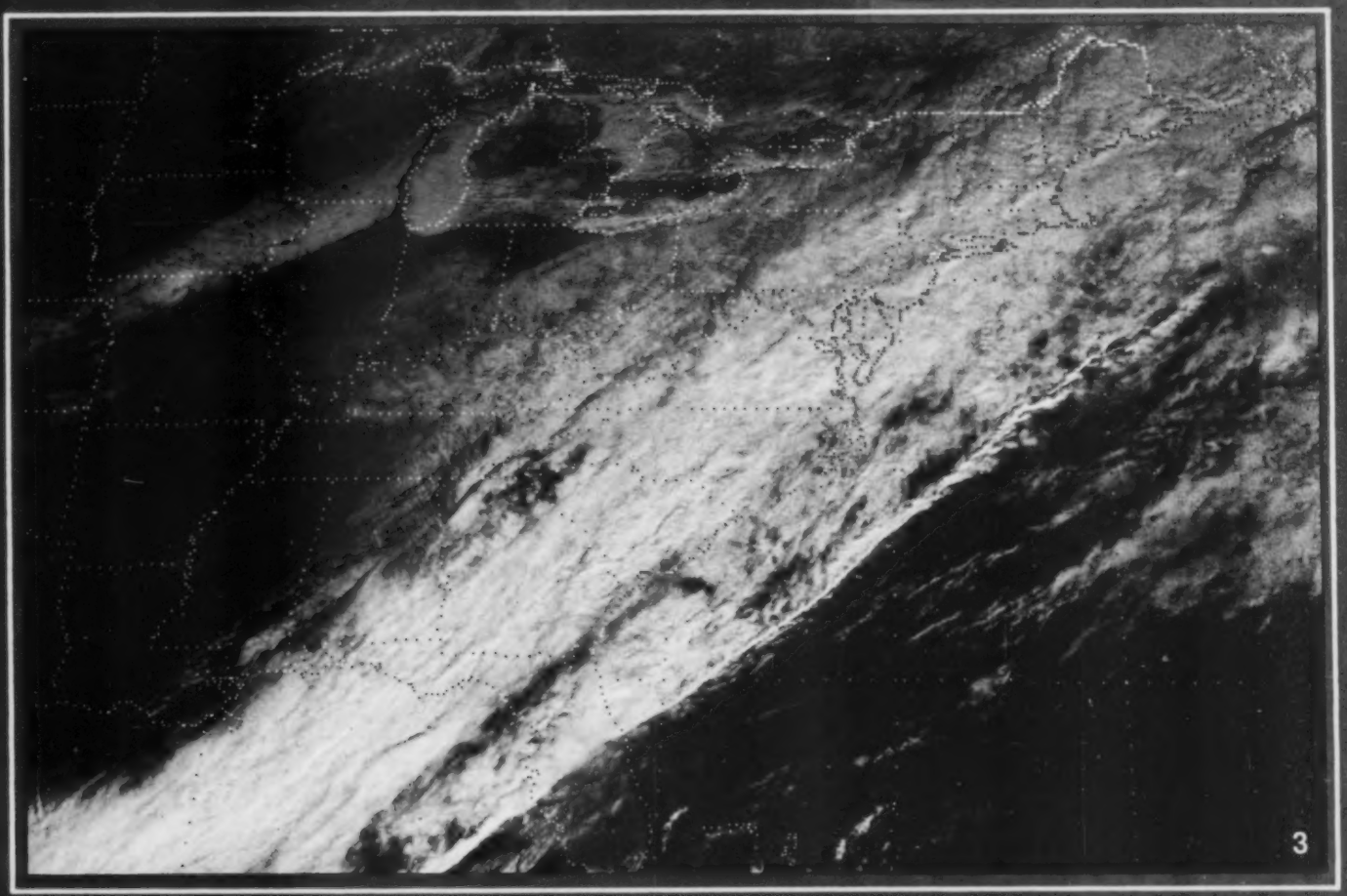
"Technology is advancing at an unprecedented rate and the potential applications to fisheries problems are limitless," says Dr. Kemmerer. "Techniques such as lasers, high-resolution color television and hydroacoustics will be investigated. The advent of the Sea Satellite (SEASAT) will provide the first opportunity to use data acquired by satellite systems designed specifically for oceanographic purposes. Data management techniques will be expanded and improved to provide more comprehensive, workable data bases to process and analyze massive quantities of integrated data. Harvesting systems will be developed and improved to facilitate harvests of latent resources and selectively harvest target species. However, the key to the future lies in the successful transfer of new techniques to user groups and the recognition by users that the new techniques can successfully replace the old standards." □

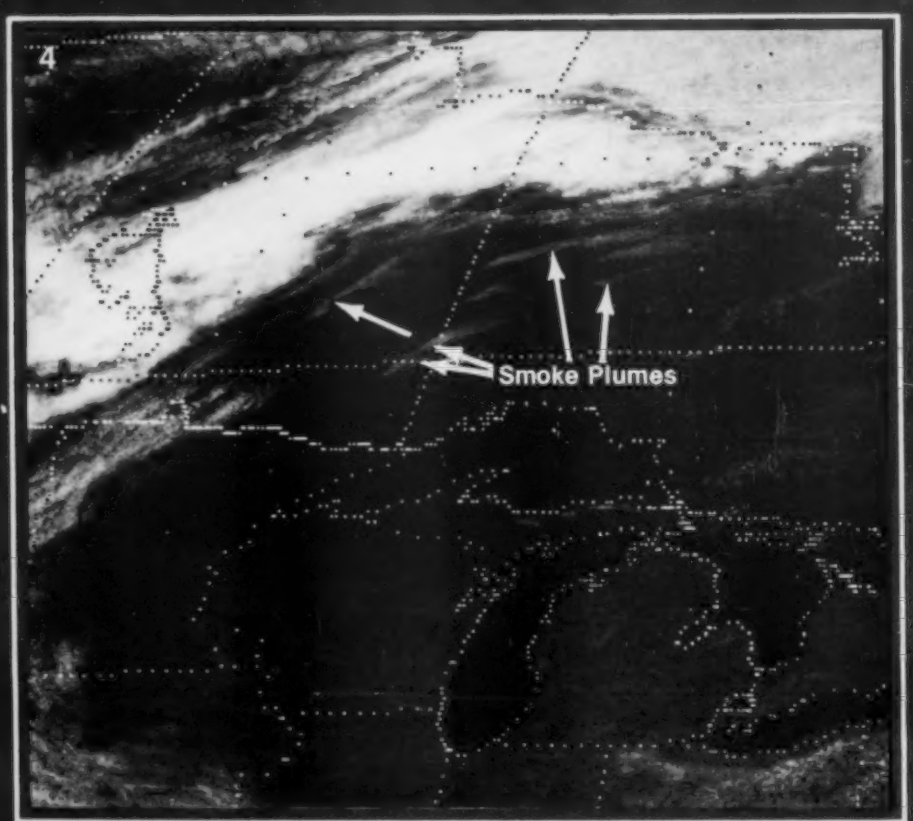


THE VIEW FROM SPACE



To most viewers of satellite imagery, one picture looks pretty much like another. But to the analysts at the National Environmental Satellite Service, each picture from space represents a challenge: to find something new or unusual in it. Shown are the successful results of several of their searches.





1 The effects of a record cold winter are seen in this January 11 GOES picture, with ice clogging the Mississippi River, ice and snow covering the Ohio River, and ice beginning to close up the Great Lakes. A trained observer could recognize ice as well in the upper Chesapeake Bay. The Tennessee River is open, because of its width and depth at this point. A long, snow-producing cloud plume can be seen at A-A'-A", helping explain why Buffalo experienced more snow than ever before during the 1976–77 winter.

2 Last summer, drought conditions in West Africa and a prevailing easterly wind resulted in a dust surge—an enormous cloud of dust blowing out over the Atlantic Ocean from the Sahara Desert. The sharp eyes of NESS' John Ernst detected this cloud on a GOES-1 picture.

3 Appearing exactly as its name implies, this 'rope cloud,' a hard line of cumulus clouds, extends from the Gulf of Mexico across Florida and into the Atlantic southeast of Cape Cod. The rope cloud formation, perfectly clear in this June GOES picture, marks the boundary between warm moist tropical air to the south and cold, dry air to the north.

4 To the uninformed viewer, the light colored streaks on this GOES-1 image might be seen as only streamers of windblown clouds. Analyst Frances Parmenter at NESS saw them for what they were—smoke plumes from forest fires raging in remote areas of central Canada last summer, consuming almost a million acres of woodland.

New Face At Sea Grant

By JAMES C. ELLIOTT

IN the Antarctic, there's a mountain named Ostenso. In the Arctic, there's a seamount, or mountain under the sea, named Ostenso. And in Washington, the man for whom those formations are named is the new Director of NOAA's National Sea Grant Program.

Dr. Ned A. (for Allen) Ostenso assumed direction of the Sea Grant Program in January. He came to his new position from the Office of Naval Research (ONR), where he had been Deputy Director and Senior Oceanographer of the Ocean Science and Technology Division.

A geologist, geophysicist, oceanographer, explorer, adventurer and a few other things as well, the 140-pound native of Fargo, N.D., holds scientific credentials that stretch from one pole to the other and sweep pretty wide in between. He has, for example, carried out solid-earth and marine geophysics research in North America, Africa, Europe, and Antarctica, and he's performed marine research in the Arctic and North Atlantic Oceans and in the Chuckchi, Beaufort, Greenland, Norwegian, Bering, and Kara Seas. He's had a hand in the development of the first fully automatic digital nuclear precision magnetometer and in formulating and publishing the concept of the interrelationship between the age and mean elevation of the seafloor due to thermodynamic considerations, a theory which since has been tested and proven true.

In addition, he has:

1. Been one of two geophysicists to discover the true thickness of the Antarctic Ice Cap. Before their discovery that the ice cap was about 10,000 feet thick, scientists had thought that it was from a few tens to a few hundreds of feet thick. Subsequently, he sounded the greatest ice thickness ever yet recorded—a whopping 14,000 feet.

2. Discovered that Antarctica was composed of two major land masses separated by a wide channel.

3. Made a number of significant geographic discoveries in the Arctic, including a major oceanic mountain range stretching from North America to Siberia. His geophysical studies resulted in the most accepted theory for the origin of the Arctic Ocean Basin and structural interrelations of many of its elements.

4. Conducted the first extensive geophysical research over the Beaufort Sea continental margin and western Alaska/eastern Canadian Arctic coast, which proved to be important contributions to the discovery and development of the Arctic oil fields.

5. Constructed the first aeromagnetic map of the Arctic Ocean.

Moreover, his activities have resulted in the publication of more than 50 scientific papers in scholarly journals, as well as numerous contributions to such widely-respected publications as the McGraw-Hill Yearbook of Science and Technology and the

Photos: James C. Elliott

At left, Ostenso discusses a point with Arthur G. Alexiou (r.), Associate Director for Programs in the Office of Sea Grant. Top photo shows the new Sea Grant Director (r.) at the Capitol during the time he was a Congressional Fellow working in the office of Congressman Charles Mosher (l.).

Encyclopedia Britannica. His research has been discussed or been the subject of four popular books by other authors. But beneath that appearance, say his friends, remain all those qualities that led him to traverse the Antarctic, cross the Greenland Ice Cap, prowl the Arctic or plunge down the Yukon in a flat-bottomed boat.

He's obviously a man of strong will. One former associate tells the story of when Ostenso led a site review team to a leading American university. One of the more renowned scientists on the staff there appeared to take some exception to the very close examination the visitors were giving his proposal. He became so irate, as a matter of fact, that he threatened to leave unless the panel didn't accept things exactly as he had proposed. Ostenso attempted to reason with the researcher, but he refused and continued to issue his threat to depart. Although one might say that the deck was in Ostenso's hands in a case like that, the scientist was of such great stature, that defiance appeared inappropriate, also. Nevertheless, Ostenso stood his ground. He not only did not back down, he rather quietly suggested to the scientist that if he really did want to leave, no one was going to stand in his way. Reports are that the scientists did get as far as the door, but he failed to leave. Surprisingly, the scientist and Ostenso have been the closest of friends ever since.

"If he believes in something," explained one acquaintence, "he'll fight for it all the way. Yet, he's completely realistic. I've heard him say over and over again to people, 'You understand that's the way it ought to be, and I understand that's the way it ought to be. But, unfortunately, that isn't the way it is.' "

The first day he visited the Sea Grant offices, he slipped unobtrusively into the director's office for a chat with Dr. Robert Abel, the man he would succeed. Abel, as was characteristic of him, was comfortably leaning back in his chair with his feet on the desk and talking on the phone. When he finished, he stood up, shook hands, offered the usual pleasantries, and assumed his position of comfort again. Barely a few minutes passed, the curious in the office realized, before Ostenso, too, had assumed the same position—one man on one side of the desk and the other on the other.

The name "Ostenso" is of Norwegian origin and means eastern sea, none of which information will help with the pronunciation whatsoever. If the staff has heard him correctly, however, he pronounces the first "O" in his name as "AH," and the "Ahstenso" comes out the same way you'd say Lorenzo.

He is the youngest of five children. When he was six years old, the family moved from Fargo to Ladysmith, Wisc., where he attended public schools until his junior year in high school when the family moved again, this time to Chippewa Falls, Wisc. His father, a banker and later an oil company executive, insisted that all the children get a college education.

When his turn came, young Ned wanted to go the Naval Academy. A slight congenital curvature of the spine, discovered during his physical examination, eliminated him from that pursuit, however. As a result, he enrolled in the University of Wisconsin. He had not the slightest idea of what he wanted to be. He insists that the primary reason for his getting into geology was more out of an overpowering desire for sleep than an overwhelming interest in the subject.

"It was the only science course a freshman could take that didn't start at 7:45 in the morning," he laughed.

"The first couple of years," he explained, "I didn't take school very seriously at all. I always was able to find things to occupy my time that seemed more interesting than sitting in a classroom."

He developed purpose in his education while working at a cannery factory the summer between his sophomore and junior years. And he found professional direction during his senior year, when he enrolled in a course taught by Professor George Woollard.

"As I was standing there stuffing cans into the machine," he recalled of his revelation, "the foreman came around with a clipboard in his hand. All of a sudden I realized that there are two kinds of people in the world. There are people who stuff cans into a ma-

As a student at the University of Wisconsin (top left), Ostenso wore a crew cut. Working with Dr. Charles L. Bentley (l.) in the Antarctic, he had a beard and probably cold hands that made recording the data a little difficult. Above, (light jacket) he poses with Navymen with whom he worked in the Arctic.

chine, and there are people who walk around with clipboards. To me, it looked like the guy with the clipboard had the better job. So I figured I'd better get off my tail and do something at school, or I'd just be throwing four years down the drain.

"George Woollard," he beamed, "really turned me on. He made all that dead stuff in the books come alive. Instead of talking about things that *HAD* been done, he talked about things he was doing—next-generation stuff. I really began to see science in action."

Through the years, Ostenso has maintained a close personal relationship with his former professor. One gets the impression that Woollard looks upon Ostenso not only as a protege of sorts, but also as a "chip off the old block," an individual possessed of the same traits and talents that have made Woollard the world-renowned geophysicist he is. Pin him down, however, and he chortles that the only reason he remembers Ostenso so well is that "when you have a bunch of students, you only remember the oddballs."

Having accepted science as his profession, Ostenso remained at the University of Wisconsin following his graduation and earned his Master's Degree. That came in 1953. Because of an ROTC commitment, he then entered the Army. Following a brief indoctrination at Fort Monmouth, N.J., he was sent to Fort Huachuca, Ariz., where—believing that meteorology was about as close as geology as one could get in the Signal Corps—he became a meteorologist.

When pilots in the fledgling aviation unit there kept muttering about altimeter problems, the young and energetc second lieutenant obligingly set about finding an answer for them. As a matter of fact, the answer proved to be one of his first discoveries. It also set the curtain on his career in the desert. He found that the Army itself had goofed. Someone had inadvertently listed the elevation of the base's old field on all the maps. It now was using a new field, though, and the error was about 2,000 feet. This having been bared, Ostenso quickly volunteered for reasignment. The Army just happened to have an immediate opening in—of all places—Alaska.

There, he performed meteorological tasks for the Army Arctic Center. In his free time, he made gravity studies all over Central Alaska. He traveled on anything that would move, he remembered, an enthusiasm that nearly proved disastrous. One plane in which he had bummed a ride crashed while landing on a glacier. And one jeep he had bummed ran smack-dab into a herd of buffalo, killing two of them. Ostenso must have felt some guilt, because he sent the head of one of the animals to a taxidermist and brought it home with him. It still hangs on the wall of his home just off Rock Creek Parkway in the District of Columbia.

The buffalo enjoys a better fate than another animal Ostenso had stuffed and brought home. That's a penquin from the Antarctic, which he installs as a fixture in every office he has had.

Following his tour in Alaska, Ostenso went to work in the private sector, accepting a job as a geologist with Geophysical Services, Inc. That company, now a part of Texas Instruments, was working on offshore oil exploration in Louisiana. Ostenso was there only a few months, however, before he got a call from Professor Woollard offering an opportunity to particiapte in a geophysical expedition into the interior of Greenland as a

Facing desks permit the Sea Grant Director and Mrs. Ostenso to work and talk together in their home in Washington (top). Below, Ostenso relaxes in another area of the home with the Sunday paper.

prelude to taking part in the exploration of the Antarctic during the International Geophysical Year (IGY). Ostenso accepted, went to Thule where the expedition members confiscated almost all their equipment and supplies from the junkyard and spent a few very "hungry" months traveling along the 80th parallel in a "weasel."

On the first trip to the Anarctic in 1956, he was a member of the party which made the first traverse from Little America to Byrd Station. He wintered over on that trip, an experience that permitted him to make many of his findings concerning the thickness of the ice cap. On his second trip in 1958, most of his work was done by airborne traverse, in a DC3.

Between those trips, he worked at the University of Wisconsin, where most of the data from the traverses had been collected and now was being reduced and analyzed. He returned to the university following his second trip and later went to Europe and Western Africa to make gravity measurements at a number of locations. Upon completion of the work in Africa, he rejoined the faculty at the University of Wisconsin, where he initiated an Arctic Research Program. He also earned his Ph.D. Degree. It was during this period that he married Grace Laudon, a nutritionist who also was earning her Ph.D. Ultimately, they became the first husband and wife hired as faculty members of the university. She now works for the Department of Agriculture in Washington.

By this time, the Navy had taken notice of Ostenso. It asked him to come to work with the Office of Naval Research, and he did. That was in 1966, and he was assigned to the Chicago office. He transferred to ONR's Washington office in 1968 as Program Director for Marine Geology and Geophysics and became Deputy Director and Senior Oceanographer in 1971.

Since coming to Washington he has worked temporarily, while still retaining duties with ONR, with the Office of Science and Technology at the White House under Presidential Science Advisor Lee Dubridge. And he has played an extremely active role as a member of a number of boards, panels and negotiating teams dealing with a host of oceanographic and international problems.

In 1975, he took a sabbatical to become a Congressional Fellow. In that program, he studied for one semester at the Johns Hopkins School for Advanced International Studies and worked on the "Hill" as a staff member first in the office of Congressman Charles A. Mosher of Ohio and later in the office of Senator Lee Metcalf of Montana.

To him, it was one of those completely unforgettable experiences, an intriguing adventure into something that was as foreign to him as a briar patch is to a whale.

"I was magnificently ignorant about the legislative process," he confesses. It was because of that ignorance that he chose the "Congressional College of Knowledge," however. He explains it this way:

While I had devoted a lot of effort to learning the science end of my business, I felt I had really put no effort at all into learning the management and political process end."

His principal activity while assigned to Congressman Mosher's office was to draft a National Atmospheric and Oceanic Climate Bill and an Earthquake Hazard Reduction Bill, both of which failed to win passage. In Senator Metcalf's office, he was occupied with the Law of the Sea, with Strategic Stockpiles of Materials, and with the Deep-sea Mining Bill.

He first became acquainted with Sea Grant, he said, when he helped Robert Ragotzkie, now Director of the Sea Grant College Program at the University of Wisconsin, prepare his first proposal for a Sea Grant. He thinks, but he's not sure, that the proposal won approval.

Because of the parallels between Sea Grant and some of the programs he directed at ONR, the 46-year-old Ostenso has been aware of much of what has been taking place in the program he now directs. He has accepted that assignment with enthusiam, and he's particularly excited about the new dimensions he hopes Sea Grant will move into with international programs, education and fellowships. One former associate summed up the situations:

"Ned is realistic about what can be done in the ocean science community generally—that is, in the states, nationally, and internationally. He's been emerging more and more in internatioal oceanography. Geologically, he has a long and successful track record. He had been a geophysicist, pure and simple. He's acquired new breadth while at the Office of Naval Research that has put him more in touch with the other sciences—marine biology and others. He knows how applied research works, and he understands it. He has not yet been exposed to the social science spinoffs that he will find in Sea Grant, but he'll grasp that quickly, also.

"In a way, he's a lot like Harry Truman, a man of principle and integrity, and a guy who always will be candid about everything."

Rear Admiral J. Edward Snyder Jr., Oceanographer of the Navy and Naval Deputy to the Administrator of NOAA, who was Ostenso's boss at ONR, described the new Sea Grant Director as "one of our most capable individuals in the international oceanographic arena."

"Ned," he said, "will be an extremely difficult act to follow." □

Storm or shine, their reports are loud and clear

Sentinels of Marine Weather

By LEROY H. CLEM*

At least once every three hours, approximately 20 unmanned environmental buoys moored at strategic locations within a few hundred miles of the coast of the United States monitor weather and ocean conditions. Measuring air pressure and temperature, winds and waves, and water temperature to a depth of a few hundred meters, each of these floating automatic systems contains an assortment of components representative of technological excellence in development: environmental data measurement sensors, control and data processing systems, a radio communication system, and a power supply with a capability of one to three years of operation.

Data buoys are floating observation stations that collect environmental information, store it, and send it to shore. Already deployed are several experimental models ranging from polar application to deep ocean buoys in the Arctic and in water adjacent to the United States. A prototype network of environmental buoys is in operation in the Gulf of Alaska and off the northwest coast of the United States. About 80 drifting buoys are deployed in waters from New Zealand to Alaska. They are the "eyes and ears" of environmental monitoring organizations, such as the National Weather Service, in marine areas where manned stations would be impracticable.

The buoys represent a major evolution in U.S. technological advancement. "Our product is environmental data," says James W. Winchester, Director of the NOAA Data Buoy Office (NDBO), "and our goal is to provide data of sufficient quality or accuracy to meet our users' need at the lowest possible cost."

To achieve this objective, the NOAA Data Buoy Office in Bay St. Louis, Miss., has developed a rigorous data quality program that keeps continuous watch over the accuracy of buoy data going to operational users and to archives. As part of this effort, a buoy system data quality evaluation and improvement program is maintained, and through special test and evaluation procedures, deficiencies in the buoy systems that could affect the data quality are detected and corrective action is taken.

"Through these efforts," says Winchester, "there has been a gradual evolution of data quality improvements until the accuracy of the data is assured of being within the present realistic requirements of the operational forecasters."

Once the data is received at a shore collection station, it is converted into engineering or scientific units. The data are then put into weather message format for teletype transmission over standard National Weather Service (NWS) circuits to the National Meteorological Center (NMC) at Suitland, Md., for use and for re-transmission to other national and international users. Most buoy data are received in Suitland, Md., within 20 minutes of the observation time at sea.

At the present time, meteorological data are coded in the form of ships weather reports; subsurface temeprature data are in a contoured format similar to that of an ocean bottom topographic map; and a special wave data message describes the wave phenomena. For use in scientific research, carefully edited data are sent to NOAA's Environmental Data Service (EDS) for archiving. EDS distributes these data to users on request.

Continental shelf applications, deep ocean operations, and drifting buoy projects are the three primary environmental data buoy engineering programs. The continental shelf buoys include systems to monitor meteorological conditions at the surface, wave spectra, and sea temperatures. Deep ocean moored systems provide long-term surface meteorology monitoring, wave spectra monitoring, and subsurface ocean temperature monitoring. The drifting buoy system includes sensors for tracing currents and monitoring limited meteorological factors in the deep oceans, tracing currents along the continental margins, and monitoring ice movements and meteorological conditions in remote Polar regions. In support of these systems, a flexible and comprehensive communications and data handling system has been developed.

Under normal weather conditions, buoy observations are made and transmitted to match the standard three hourly synoptic observation times. In critical storm situations when more information about rapidly changing conditions is necessary, the buoys can be commanded from the shore to provide hourly data enabling hurricane and other

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Locations of NOAA data buoys in 1976. Two of them in the Atlantic, EB-15 and EB-41, were on the track of Hurricane Belle in August, and continued to send out their vital data as the storm passed through.

severe storm forecasters to monitor more precisely the changes occurring at sea.

Until the development of the environmental data buoy, detailed information about surface conditions at sea during a severe storm or a hurricane was not readily available to forecasters. Most ships will do their best to avoid these conditions, but on those ships caught in severe storms, the crews' attention is devoted to safeguarding the ship and little time is left for the dangerous task of obtaining and transmitting a series of much needed weather reports. Conversely NDBO buoys are moored at critical locations and are designed to survive and report conditions throughout the storms that pass near them.

Last August, Hurricane Belle churned its way northward off the east coast and headed for New York and New England. Its path took the eye of Belle, on August 9, 1976, directly over Environmental Buoy-15 some 300 miles east of Savannah, Ga., and late the same day, just west of Environmental Buoy-41 located about 60 miles southeast of Cape May, N.J.

Designed to withstand severe storm conditions at sea, EB-15 is a large 12-meter discus-shaped, deep-ocean moored data buoy, with sensors at 10 meters above sea level. Deployed during mid-summer 1974, EB-15 is the third large NDBO data buoy that was exposed to the full fury of a hurricane and that operated normally throughout. Two buoys in the Gulf of Mexico, EB-04 and EB-10, stood up to the violence of Hurricane Eloise in September 1975, and continued to deliver valuable data as the eye brushed by them.

Smaller than its predecessors, the continental shelf buoy EB-41 has a five-meter discus-shaped hull with sensors at five meters above sea level. It was designed for use in more moderate environments on the continental shelf, and might not have been expected to remain operational during the passage of a hurricane. The stability of this smaller buoy and its reliable operation, however, were well tested during the passage of Hurricane Belle.

"It not only survived," says Winchester, "but performed well, delivering hourly data on the details of the storm."

Under NDBO management policies, data of good quality must be combined with high reliability for data buoy operations and balanced with value engineering to arrive at an acceptable buoy system capable of providing worthwhile data to the users at an affordable cost. Improved performance and reliability as well as expanded measurement capability to meet realistic needs on a user acceptable cost/value basis are the goals of NDBO's technology development programs. The evolution to a reliable low cost payload, often called the buoy electronics system, is an example of the progress made by the technology development efforts at NDBO.

The payloads for NDBO's first buoys were developed in 1971 with little experience in advanced state-of-the-art hardware design. Six years ago, the major requirement was that the buoys were to have excessive flexibility in order to perform a spectrum of engineering and data acquisition tests necessary for establishing the state-of-the-art of buoy technology. Designed to meet what now appears to have been unrealistic data accuracy requirements, these complex payloads were expensive and not particularly reliable.

By eliminating many of the original features of these early buoys, by establishing far more realistic data accuracy requirements, and by taking advantage of demonstrated advances in low-powered electronics, NDBO was able to begin procurement in 1974 of operational Prototype Environmental Buoy (PEB) payloads for about one-third the cost of the payloads of the buoys developed in 1971. Reliability was gained by reducing the complexity of the system.

Within a year, following the trend of cost reductions in digital electronic hardware and technology, NDBO was able to procure a payload, comparable to the PEB in capability, at a further reduction in cost to approximately one-half the cost.

In late 1975, a major effort was undertaken by NDBO to obtain a new low cost payload by further simplifying the payload system and taking advantage of the soon to be available Geostationary Operational Environmental Satellite (GOES) relay system which requires less expensive buoy components. Currently, the control system of the buoy activates the sensors to take measurements of air pressure and temperature, winds and waves, and water temperature which the data processing system averages for each characteristic, to obtain a representative value of the true conditions of the marine environment for that period of time. After processing, these averaged values are stored on the buoy in electronic memory until at a time preset in the control system, the information is telemetered to the shore collection station via high frequency (HF) radio. With the GOES satellite relay system, data will be telemetered by the even more reliable ultra high frequency (UHF).

Winchester anticipates still another significant reduction in the cost of these basic payloads which will use the GOES relay system for data telemetry. "Initially it is expected that these new low cost payloads, to meet basic data requirements, will be used for reimbursable projects making buoy technology affordable to more potential data users." He says that these new low cost payloads are scheduled for operational testing next fall.

In the meantime, NDBO continues its programs under the Office of Ocean Engineering to advance data buoy technology in order to provide data of good quality from reliable buoys at desired locations to meet users' data needs. The locations and the priorities for deploying data buoys are established by NOAA headquarters in Rockville, Md., after coordination with other government agencies and data users.

Among the highest priorities is NOAA's effort to provide data support to operational forecasts in those areas that include energy related projects—the marine leg of the Trans Alaskan Pipeline System and the Outer Continental Shelf Assessment Program.

"As requirements for this type of service increase," says Winchester, "buoys deployed at NOAA's direction will provide even better coverage and data support to our national marine interests and operational forecasters." □

From Alaska, Oregon and Washington

Seafood Moods

Sea Fare

The majestic beauty of Washington, Oregon, and Alaska can be matched only by the bountiful seafood harvest from these states. The fresh beauty of these products is unsurpassed. From the rugged magnificence of the Oregon coast, to the satisfying solitude of Puget Sound, north to the haughty grandeur of Mount McKinley . . . this land is truly a land of many moods. These moods are also reflected in its waters, and its seafoods become foods of many moods. From the successes of their salads to the succulence of their casseroles, North Pacific fish and shellfish offer the homemaker a wealth of Seafood Moods.

So . . . select a mood. . . . Select a food . . . a seafood from Washington, Oregon, or Alaska. . . . Add some imagination and your own special twist and enjoy . . . enjoy . . . enjoy. . . . It's the next best thing to visiting there.

Halibut Steak With Orange-Grape Sauce

2 pounds halibut or other fish steaks (¾-inch), fresh or frozen
2 cups boiling water
2 tablespoons lemon juice
1 teaspoon salt
1 tablespoon cornstarch
1 tablespoon sugar
½ cup orange juice
½ cup cold water
2 teaspoons grated orange rind
1 teaspoon lemon juice
1 can (11 ounces) mandarin orange segments, drained
1 cup seeded green grape halves

Thaw frozen fish, and cut into 6 serving portions. Place fish in a well-greased, large frypan. Add boiling water, lemon juice, and salt. Cover; simmer until fish flakes easily when tested with a fork, 8 to 10 minutes. While fish is cooking, prepare sauce. Combine cornstarch and sugar in small saucepan. Stir in orange juice and cold water. Cook slowly, stirring constantly, until thickened. Stir in orange rind, lemon juice, and fruits; heat. Transfer cooked, drained fish carefully to hot serving platter. Spoon sauce over halibut. Makes 6 servings.

Crab Crepes With Shrimp Sauce

Crepes
½ cup milk
1 egg
½ cup sifted flour
¼ teaspoon salt

Filling
1 cup (6 ounces) frozen snow crabmeat or other crabmeat, flaked
½ cup thinly sliced celery
2 tablespoons thinly sliced green onions
¼ cup salad dressing
2 tablespoons diced pimiento
1 teaspoon curry powder
1 teaspoon lemon juice
½ teaspoon Worcestershire sauce

Sauce
1 can (10 ounces) frozen, condensed shrimp soup, defrosted
½ cup milk
½ cup tiny, cooked Pacific pink shrimp, optional
1 teaspoon lemon juice

To make crepes: Combine milk, egg, flour, and salt; beat until smooth. Fry crepes, one at a time, in lightly greased 6- or 7-inch skillet, using 3 tablespoonfuls batter for each crepe. Pour batter into skillet; tilt pan quickly so that batter will cover bottom of pan. Cook until lightly browned on both sides, turning once. Stack and keep warm while preparing filling.

To make filling: Thaw crabmeat; combine crabmeat, celery, onion, salad dressing, pimiento, curry powder, lemon juice, and Worcestershire sauce; mix carefully. Spread an equal amount of filling over each crepe, and roll up. Arrange filled crepes on heat-proof platter. Cover with aluminum foil, crimping foil to edges of platter. Bake in a moderate oven, 350° F., about 15 minutes or until well heated. Prepare sauce while crepes are heating.

To make sauce: Combine soup, milk, shrimp, and lemon juice; warm to serving temperature over low heat, stirring constantly.

To serve: Uncover platter and pour sauce over crepes. Makes 6 crepes or 6 servings.

Smoky Sablefish or Salmon Dinner Salad

1 cup salad dressing or mayonnaise
1 teaspoon prepared mustard
½ teaspoon tarragon leaves
½ teaspoon salt
¼ teaspoon celery seed
3 cups chilled, sliced, cooked potatoes
2 cups sliced celery
⅗ cup sliced radishes
⅓ cup sliced green onions
½ pound smoked sablefish, salmon or other smoked fish, flaked
Lettuce leaves

Combine first 5 ingredients; mix well. Fold in sliced potatoes. Cover; refrigerate several hours to blend flavors. Add celery, radishes, onion, and flaked fish; mix carefully. Arrange in center of lettuce-lined serving dish; garnish with additional sliced smoked sablefish or salmon, albacore tuna, or Pacific pink shrimp. Makes 6 servings.

Halibut Pot Roast

3-pound chunk halibut, salmon, or other firm fish, fresh or frozen
12 medium-size carrots, peeled
6 medium-size raw potatoes, peeled
2 cups sliced celery
⅓ cup water
1 clove garlic, minced
⅓ cup butter or margarine, melted
2 teaspoons salt
¼ teaspoon pepper

Thaw frozen fish. Center fish in large, well-greased baking pan. Arrange vegetables around fish. Combine water and garlic; pour over fish and vegetables. Brush fish and vegetables with butter or margarine. Sprinkle with salt and pepper. Cover with foil, crimping to edges of pan. Bake in moderate oven, 350° F., 1 hour or until vegetables are tender and fish flakes easily when tested with a fork. Transfer fish and vegetables to heated serving dish. Serve with pan drippings if desired. Makes 6 servings.

Halibut Steak with Orange Sauce (left), Crab Crepes with Shrimp Sauce (top), and Smokey Sablefish or Salmon Dinner Salad (above).

Halibut Pot Roast (top) and Fruity Tuna Salad (above).

Broiled Steaks with Herb Sauce (top), and Baked Rockfish or Sea Bass with Spinach and Bread Stuffing (above).

Rainbow Trout with Mushroom-Herb Stuffing (top) and Northwest Cioppino (above).

Sweet and Sour King Crab (above), Alaskan Fisherman Stew (top) and Crispy Scallop Salad Bowl (right).

Fruity Tuna Salad

⅔ cup salad oil
⅓ cup honey
⅓ cup lemon juice
1 tablespoon grated onion
1 teaspoon salt
1 teaspoon dry mustard
½ teaspoon paprika
½ teaspoon celery seed, optional
3 cans (6½ to 7 ounces each) albacore tuna, drained, broken in chunks
Crisp salad greens
1 can (1 pound 4 ounces) pineapple chunks or slices, chilled and drained
2 large oranges, peeled and sliced
1 ripe avocado, peeled and sliced
Mint sprigs or watercress

Combine first 8 ingredients in large bowl; mix well. Add tuna; cover and refrigerate several hours. Drain tuna; save marinade. Line shallow salad bowl or serving platter with salad greens; pile drained tuna in center of dish. Arrange pineapple, orange, and avocado slices around tuna. Garnish with mint sprigs or watercress. Serve with reserved marinade or, if preferred, honey-celery seed dressing. Makes 6 servings.

Broiled Steaks With Herb Sauce

6 salmon steaks or other fish steaks, (¾-inch) fresh or frozen (about 2 pounds)
¼ cup butter or margarine
¼ cup dry white wine
1 tablespoon chopped parsley
¼ teaspoon fines herbes blend
1 clove garlic, sliced
1 teaspoon salt

Thaw frozen steaks. Combine butter or margarine, wine, parsley, herbs, and garlic; heat slowly until fat is melted. Let stand 15 minutes. Sprinkle steaks with salt. Place fish on a well-greased broiler pan; brush with sauce. Broil about 3 inches from heat source, 4 to 6 minutes. Turn carefully; brush with sauce. Broil 4 to 6 minutes longer or until fish flakes easily when tested with a fork. Baste steaks with sauce several times while broiling. Makes 6 servings.

Baked Rockfish or Sea Bass With Spinach and Bread Stuffing

3- or 4-pound dressed rockfish, sea bass, or other firm fish, fresh or frozen
2½ teaspoons salt
1½ cups thinly sliced celery
¼ cup sliced green onions
½ cup butter or margarine, melted
4 cups soft bread cubes (½-inch)
4 cups fresh spinach leaves, washed, well-drained
1 tablespoon lemon juice
¼ teaspoon pepper

Thaw frozen fish; clean, wash, and dry fish. Sprinkle inside and outside with 1½ teaspoons salt. Cook celery and onion in 6 tablespoons butter or margarine until celery is tender. Stir in bread cubes and spinach leaves. Cook and stir until spinach is tender. Add lemon juice, remaining 1 teaspoon salt, and pepper; toss lightly. Stuff fish loosely. Close opening with small skewers. Place fish in well-greased baking pan. Brush with remaining butter or margarine. Bake in a moderate oven, 350° F., 40 to 60 minutes or until fish flakes easily when tested with a fork. Makes 6 to 8 servings.

Rainbow Trout With Mushroom-Herb Stuffing

6 pan-dressed rainbow trout or other pan-dressed fish, fresh or frozen
2 teaspoons salt
4 cups (½-inch) soft bread cubes
⅔ cup butter or margarine
1 cup sliced fresh mushrooms
⅔ cup sliced green onions
¼ cup chopped parsley
2 tablespoons chopped pimiento
4 teaspoons lemon juice
½ teaspoon marjoram

Thaw frozen fish; clean, wash, and dry. Sprinkle 1½ teaspoons salt evenly over inside and outside of fish. Saute bread cubes in ½ cup butter or margarine until lightly browned, stirring frequently. Add mushrooms and onion; cook until mushrooms are tender. Stir in remaining salt, parsley, pimiento, lemon juice, and marjoram; toss lightly. Stuff fish, and arrange in single layer in a well-greased baking pan. Brush with remaining melted butter or margarine. Bake in a moderate oven, 350° F., 25 to 30 minutes or until fish flakes easily when tested with a fork. Serve plain or with favorite fish sauce. Makes 6 servings.

Northwest Cioppino

1½ pounds halibut, lingcod, rockfish, or sea bass, fresh or frozen
2 cups sliced onion
2 cloves garlic, finely minced
¼ cup cooking or olive oil
1 can (1 pound 12 ounces) Italian tomatoes, undrained
1 can (8 ounces) tomato sauce
1 cup water
¼ cup chopped parsley
2 teaspoons salt
1 teaspoon basil
½ teaspoon oregano
¼ teaspoon pepper
1 dozen clams in shell, washed
1 cup cooked, peeled, Pacific pink shrimp

Thaw frozen fish, and cut into 1½-inch chunks. Cook onion and garlic in oil until onion is tender but not brown. Add tomatoes, tomato sauce, water, parsley, salt, basil, oregano, and pepper. Cover. Simmer gently about 30 minutes. Add fish chunks; cover and simmer 10 to 20 minutes. Add clams in shells and shrimp; cover; cook 10 minutes longer or until fish flakes easily when tested with a fork. Makes 6 to 8 servings.

Alaskan Fisherman Stew

2 pounds rockfish, lingcod, Pacific ocean perch, salmon, halibut, or other firm fish, fresh or frozen
1½ cups sliced celery
½ cup chopped onion
1 clove garlic, minced
¼ cup butter or margarine
1 can (1 pound 12 ounces) tomatoes, undrained
1 can (8 ounces) tomato sauce
2 teaspoons salt
½ teaspoon paprika
½ teaspoon chili powder
¼ teaspoon pepper
1 package (7 ounces) spaghetti, uncooked
2 cups boiling water
¼ cup grated or shredded Parmesan cheese

Thaw frozen fish, and cut into 1-inch chunks. Cook celery, onion, and garlic in butter or margarine in large, heavy pan until tender. Add tomatoes, tomato sauce, and seasonings. Bring to a simmer; cover; cook slowly 15 to 20 minutes. Add uncooked spaghetti and boiling water; mix; cover pan. Cook slowly about 10 minutes or until spaghetti is almost tender. Add fish; cover; cook slowly about 10 minutes or until fish flakes easily when tested with a fork. Serve hot with cheese sprinkled over top. Makes 6 servings.

Sweet and Sour King Crab

2 packages (6 ounces each) frozen king crabmeat or other crabmeat, fresh or frozen
1 cup sliced onion
1 small green pepper, cut in 1-inch squares
¼ cup butter or margarine
1 can (1 pound 4 ounces) pineapple chunks in heavy syrup
½ cup sugar
2 tablespoons cornstarch
½ teaspoon dry mustard
¼ teaspoon salt
½ cup white vinegar
1 tablespoon soy sauce
⅔ cup cherry tomato halves or thin tomato wedges
6 servings hot, cooked, seasoned, plain or almond rice or chow-mein noodles

Thaw frozen crabmeat. Saute onion and green pepper in butter or margarine until onion is tender, not browned. Drain pineapple; reserve syrup. Combine sugar, cornstarch, mustard, and salt. Stir in pineapple syrup, vinegar, and soy sauce; mix well; add to onion-green pepper mixture. Cook, stirring constantly, until thick and clear. Fold in pineapple chunks, crabmeat, and tomatoes. Heat; serve over rice or noodles. Makes 6 servings.

Crispy Scallop Salad Bowl

1½ pounds scallops, fresh or frozen
1½ cups water
3 tablespoons lemon juice
1½ teaspoons salt
3 peppercorns
3 slices onion
½ cup tarragon vinegar
⅓ cup salad oil
⅓ cup sugar
1 clove garlic, sliced
1½ cups diagonally sliced celery
6 servings crisp salad greens
¾ cup sliced radishes
3 hard-cooked eggs, sliced
1 pint cherry tomatoes, cut in half, or 2 tomatoes, cut in wedges
¼ pound cheddar cheese, cut in thin strips

Thaw scallops; rinse with cold water; drain well. Combine water, lemon juice, ½ teaspoon salt, peppercorns, and onion in sauce-pan; bring to a boil. Simmer 5 minutes. Add scallops; cover and simmer gently 5 to 10 minutes or until scallops are tender. Drain scallops. Combine vinegar, oil, sugar, remaining 1 teaspoon salt, and garlic; stir until sugar is dissolved. Pour over scallops. Cover; chill several hours. Add celery; mix and drain; save marinade. Arrange greens in large salad bowl. Pile scallops and celery in center of bowl, and arrange remaining foods in groups around scallops on crisp salad greens. Serve with reserved marinade or, if preferred, favorite French or oil-and-vinegar dressings. Makes 6 servings.

AN ISLAND OFF GEORGIA

Nation's newest sanctuary

SAPELO Island, Georgia, has become the Nation's second estuarine sanctuary. It was established by the State of Georgia and NOAA last January, after more than two years of study and preparation.

Sapelo Island follows Coos Bay, Oregon, as a natural-resource refuge. The island is located just north of St. Simons Island on Georgia's Atlantic Coast. Although not noted as a resort mecca, it is a beautiful island that is the site of the Blackbird National Wildlife Range, a Natural Outdoor Recreation Area, a State Wildlife refuge, and now a National Estuarine Sanctuary. Sapelo Island is rich in both natural and social history. Many years prior to its discovery by Portugese sailors in 1520, Creek Indians hunted the island's forests, which abound with wildlife, and fished the tidal creeks and the sea.

As has been true for generations since, the land and sea provided ample sustenance for the island's inhabitants.

The primitive land became a focal point for big power politics in the 17th and 18th centuries. Between 1550 and 1690 Spanish Jesuits and Franciscans had settled along the coast and founded missions, extending Spanish influence northward from their Florida base. The British government, to protect its South Carolina colony from invasion by the Spaniards in Florida and by the French in Louisiana, in 1732 granted a charter to a group of trustees headed by James Oglethorpe, to found a British colony in Georgia. On the outbreak of war between Britain and Spain in 1739 Oglethorpe defended the colony with great success, and in the treaty of peace that followed, the land was ceded to England. As part of the overall settlement, the Lower Creek Nation gave Sapelo island to George II, King of England.

However, the local Indians refused permission for the British charterers to use the island, so it remained outside their jurisdiction until expiration of the charter in 1753, when the colony became a royal province. Four years later British settlers began moving onto the island.

Photo: Joe Maher

Georgia's Governor George Busbee designating Sapelo Island as the nation's second National Estuarine Sanctuary.

Among the several colonists who owned tracts on Sapelo Island was Andrew McKay, who ultimately gained control. Following his death, his son sold Sapelo to Frenchmen who were fleeing the revolution. The original charter had forbidden slavery in the colony, but with its expiration the practice was introduced, and the French settlers brought Sapelo island for this purpose.

Later, the island fell into the hands of Thomas Spaulding who began extensive agricultural practices and initiated a large and successful cattle operation.

Following the Civil War, Howard Coffin purchased Sapelo Island and undertook the task of restoring the plantation, which had been hard hit by the war. During this period he rebuilt the main house and the outbuildings.

Tobacco magnate R.J. Reynolds purchased the island in the early 1930's. He did much renovation, and built the quadrangle that today houses the Sapelo Island Marine Institute. Reynolds also established the Sapelo Island Research Association; it was his desire that the island be protected and used as an environmental laboratory. His house and dairy barn today serve as the site of a Marine Laboratory.

A research park also exists on Sapelo Island, where cooperative programs between the University of Georgia and the Sapelo Island Research Foundation have, over the past two decades, established a baseline of important data just as Reynolds had envisioned many years ago.

Thus this ten-mile long, four-mile wide island, with its more than five miles of ocean front and assiciated sandy and silty beaches and dunes development, became a prime candidate for designation as an "estuarine sanctuary," under the concept embodied in the Coastal Zone Management Act of 1972.

An Estuarine Sanctuary, as provided in the act, is basically a research area that may include any part of an estuary, adjoining transitional areas, and adjacent uplands. It is set aside to provide scientists and students the opportunity to examine, over a period of time, the ecological relationships within the area.

It was therefore a natural and logical development, to bring a relatively undisturbed estuary with a research history like Sapelo Island into the National Estuarine Sanctuary Program.

Georgia first acquired nearly 13,000 acres of Sapelo in 1969. The State received the property from Dr. Annemarie S. Reynolds, widow of R.J. Reynolds, partially as a gift and for a purchase price to the state of $835,000, with 25% in state funds and 75% provided by the Federal government.

In December 1976 Governor Busbee announced the acquisition of the south end of Sapelo Island off the Georgia coast. With this acquisition the State owns all but approximately 400 acres of Sapelo Island. The new acquisition consisted of more than four thousand acres with a purchase price of $4 million, of which the state provided $2 million, NOAA $1.5 million and the Bureau of Outdoor Recreation of the State of Georgia $500,000.

In ceremonies in his office in Atlanta, the Governor described this new acquisition as a "Christmas Gift" to all citizens of Georgia and the nation. The Sapelo Island Research Foundation, in selling this final 4,000 acres, assured that the natural features of the island will never be compromised.

Its acquisition gives the State control of all except the 400 acres that encompass the small community of Hog Hammock, whose inhabitants are descendants of early colonial residents of the island. Governor Busbee pointed out that the well-being of this community is important ot the State of Georgia, and that the rights of its citizens will be fully protected.

The newly acquired acreage will serve as the nation's second National Estuarine Sanctuary; the remainder of the land will be a natural area. The University of Georgia Marine Institute on Sapelo will continue its research and educational programs and the Sapelo Foundation will continue to finance research programs.

Joining in the signing and acquisition ceremonies was Robert W. Knecht, Associate Administrator for Coastal Zone Management, representing the National Oceanic and Atmospheric Administration.

During the ceremonies Mr. Knecht said, "This action today assures that the estuarine sanctuary will remain a permanently protected unspoiled area—a natural laboratory for scientific research and education." □

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NOAA Administrator Announces Resignation

Dr. Robert M. White, NOAA Administrator, has announced his resignation from Federal service, effective July 15. Head of NOAA since it was created, and of its predecessor agencies—the Environmental Science Services Administration (ESSA) and the U.S. Weather Bureau—the distinguished meteorologist and science administrator is leaving the Government after 13 years of service under five Presidents.

In his letter of resignation to Secretary of Commerce Juanita M. Kreps, Dr. White cited "compelling personal reasons" for his decision, noting that "it is difficult after all these years of directing the Nation's oceanic and atmospheric efforts to leave. I am deeply grateful to you for your confidence in me that has led you to express the desire that I remain Administrator of the National Oceanic and Atmospheric Administration."

Sec. Kreps, in replying to Dr. White, said:

March 21, 1977

Dear Bob:

It is with deepest regret that I accept, on behalf of the President, your resignation as Administrator of the National Oceanic and Atmospheric Administration. President Carter and I had looked forward to your continuing the outstanding service you have rendered under the leadership of five Presidents since coming to the Department of Commerce in 1963. Your loss will be a great one.

The Nation, the Commerce Department, and NOAA and its predecessor agencies have been fortunate in having you at the helm of so many of our environmental services during a crucial period in our lives. As we have reached ever more deeply into the complex world of science in our search for understanding of the forces of nature, we have also endeavored not to lose our concern for those things around us that need mankind's special attention and protection. Thus, your official attention often was divided equally between the newest weather satellite in the heavens and to seeing to the welfare of creatures of the sea whose extinction was threatened. Your devotion to both was always evident.

In moving to other vital and demanding scientific duties, you take with you our good wishes and warm appreciation for a job well done.

Sincerely,

Juanita M. Kreps

Coastal Zone Management Reorganization Is Approved

Reorganization of the Office of Coastal Zone Management, within NOAA, has been approved by Secretary of Commerce Juanita M. Kreps.

"Purpose of this reorganization is to bring the office into line with the new responsibilities and functions mandated by the Congress," said NOAA Administrator Dr. Robert M. White. "Establishment of the $1.2 billion, 10-year Coastal Energy Impact Program provides a whole new focus for helping coastal states cope with problems that might arise incident to offshore oil and gas development. The reorganization will permit us to carry out this program effectively."

The Office of Coastal Zone Management will be headed by an Associate Administrator (of NOAA) for Coastal Zone Management, who must be appointed by the President and confirmed by the Senate. Robert W. Knecht, formerly Assistant NOAA Administrator for Coastal Zone Management, is now Acting Associate Administrator. He is assisted by Richard A. Foster, newly-appointed Assistant Associate Administrator for Operations. Their overall responsibility is to implement the provisions of the Coastal Zone Management Act of 1972 as amended, and the sanctuaries portion of the Marine Protection, Research and Sanctuaries Act of 1972.

Within OCZM there are established a State Programs Office headed by William Matuszewki, a Federal Programs Office headed by Joellyn Murphy, and a Policy and Program Development Office headed by Richard R. Gardner.

Dr. White has accepted the chairmanship of the new Climate Research Board at the National Academy of Sciences.

Under Dr. White's direction, NOAA has emerged as a key environmental management and assessment agency of the Federal Government. Its responsibilities extend from the monitoring of atmospheric pollutants for possible effects upon the ozone layer to the study of the effects of human activity on such diverse areas as the Gulf of Alaska and the New York Bight. Some noteworthy developments under Dr. White's direction have been the strengthening of the Nation's fisheries management and conservation systems and reduction of foreign fishing pressures off U.S. coasts; the development of comprehensive coastal zone management proposals by the states; creation of the first Sea Grant Colleges, the marine analogue to the Land Grant College system; and significantly improved protection of marine mammals and other endangered species.

Dr. White has represented the U.S. government in many international forums. He is the United States Permanent Representative to the World Meteorological Organization, a specialized agency of the United Nations and the United States Commissioner to the International Whaling Commission. He is the U.S. Chairman of the Joint U.S./U.S.S.R. Commission on the Exploration of the World Oceans, and the U.S. Chairman of the Joint French/American Bilateral Cooperation in Oceanography.

Dr. White has been instrumental in fostering the World Weather Program under the World Meteorological Organization, a unique program directed toward achieving longer-range and more accurate weather forecasts through more complete worldwide weather observation.

As a member of the U.S. delegation to the landmark United Nations Conference on the Human Environment, held in Stockholm in June of 1972, he was responsible for the overwhelming endorsement by the nations of the world for a complete moratorium on the commercial taking of whales, as well as the decision to develop a comprehensive international environmental monitoring system. In his capacity as U.S. Commissioner to the International Whaling Commission, he spearheaded the U.S. effort over several years which succeeded in bringing major international protective measures for the world's whale population.

Oceans Unit Honors White

The Neptune Award, highest honor of the American Oceanic Organization, will be bestowed upon Dr. Robert M. White, NOAA Administrator, at AOO's annual Neptune Award Banquet April 27, AOO President Edward M. MacCutcheon has announced.

In addition, a special Neptune award will be presented to Frank O. Braynard, principal organizer of the Tall Ships event during the Bicentennial.

The Eighth Annual Neptune Award Banquet of the American Oceanic Organization will take place at the Washington Hilton Hotel. The Neptune Award is given to a person who has made an outstanding contribution to the national oceanic program, involving strong elements of innovation and imagination, and representing a distinct recognition of and contribution to the overall public interest in the marine environment.

Centenarian Clams Good For Chowder

Would you eat an ocean quahog that was around when Ulysses S. Grant was President of the United States?

If you've had any clam chowder lately, there's a good possibility that in among the potatoes, onions, and salt pork there was a century-old clam, lending both its name and flavor to the soup.

Word of the existence of these hundred-year old shellfish, also known as mahogany clams, comes from Princeton University. There, Dr. Ida Thompson is studying the growth rates and natural mortality of ocean quahogs and surf clams, both commercially important species on the east coast of the United States.

Supported by a NOAA Sea Grant, Dr. Thompson is trying to establish a relationship between the growth rings found on the quahog's "hinge plate" and its age.

"The ocean quahog has a little tooth, called a hinge plate, where its upper shell is hinged to its lower shell," Dr. Thompson explained. "By cutting a vertical section of this tooth and then polishing it, we can see distinct growth rings under magnification, just like the rings on a tree."

Preliminary results of clam samples indicate that about 25 percent are almost 100 years old.

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NOAA Climate-Watchers Say

Dust Particles Are Not Behind Record Winter

Whatever is behind this year's record winter in the eastern United States, it is not planet-wide cooling caused by a thickening layer of atmospheric dust, NOAA climate-watchers say.

Instruments at NOAA's climate-monitoring stations at Mauna Loa, Hawaii, show no long-term change in the amount of small particles suspended in the atmosphere.

The NOAA data, based on 19 years of measurements at the observatory, suggest that human activities are not increasing the concentration of solid particles in the atmosphere at this location. Since the Mauna Loa measurements are believed to be representative of other clean-air locations around the globe, NOAA scientists see no long-term increase in the quantity of atmospheric particles in most of the earth's atmosphere.

This tends to contradict the theory that human activities are increasing the global atmospheric burden of particles, which, by reflecting and scattering sunlight back to space, could cool the planet, perhaps catastrophically.

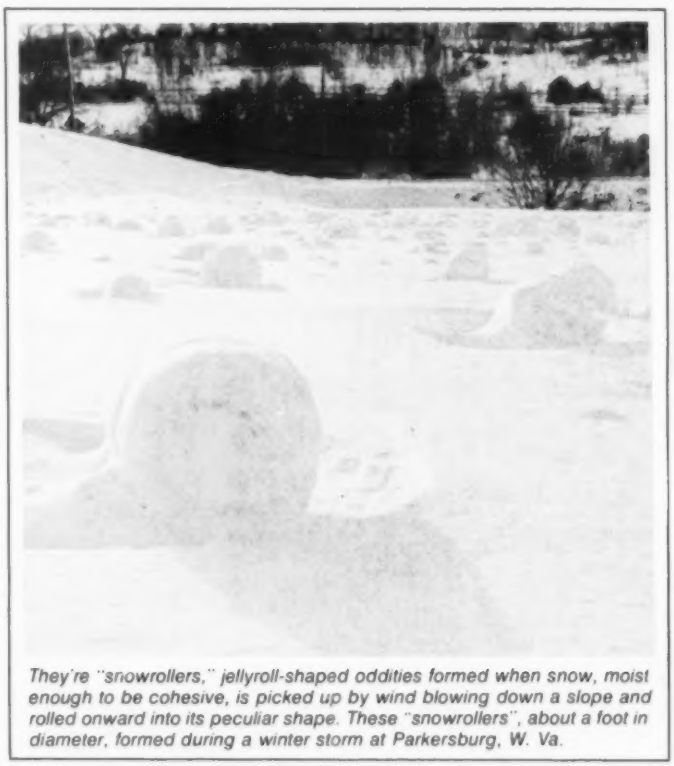
According to Dr. Kirby J. Hanson, who directs NOAA's Geophysical Monitoring for Climatic Change (GMCC) program, the Mauna Loa measurements mean there has been no detectable long-term increase in background levels of atmospheric particles.

He stressed, however, that the measurements do not mean there have been no regional increases in particle levels. "Areas that are heavily impacted by atmospheric particles from industry, duststorms, and other major sources would have higher particle concentrations. We wouldn't expect data from those locations to match the Mauna Loa observations."

The only increases in atmospheric particle concentrations observed at Mauna Loa have been transient ones, caused by large volcanic eruptions, he said.

Scientists there use measurements from pyrheliometers—sun-tracking devices which measure solar radiation—to determine atmospheric dust loading in terms of the atmosphere's "apparent transmittance."

This value is obtained by comparing measurements of solar radiation made at two different sun angles, and can be interpreted as the amount of dust between the instrument and the sun—effectively, the amount of dust from the elevation of the observatory up through the stratosphere.



They're "snowrollers," jellyroll-shaped oddities formed when snow, moist enough to be cohesive, is picked up by wind blowing down a slope and rolled onward into its peculiar shape. These "snowrollers", about a foot in diameter, formed during a winter storm at Parkersburg, W. Va.

Balloon Data Interpretation Automated

A $1.8 million program for automating the interpretation of data from instrumented weather balloons and interpretation of the information has been completed by the National Weather Service.

The program required installation of minicomputers at 93 National Weather Service stations around the country. The minicomputers speed up translation of radio signals from balloon-borne radiosondes into measurements of temperature, pressure, humidity, and wind, with 50 percent fewer errors than by previous, all-manual techniques. They also reduce from two to one the number of people needed for collecting such observations at each site, relieving one person for other duties or reassignment elsewhere.

Accurate measurements of weather conditions from the ground to high in the atmosphere, extremely important to modern-day forecasting and meteorological research, are obtained by balloon-borne radiosondes.

Weather-balloon soundings are now made at 93 Weather Service stations and at 35 weather stations elsewhere in the Western Hemisphere.

Until the new minicomputers were installed, manual reduction of data from a radiosonde was a laborious, time-consuming process, involving many repetitious steps and requiring two people for a four-hour period. Now, one observer handles it, feeding raw data to the minicomputer.

VIMS Studies Oyster Industry

Research efforts to help the Nation's oyster industry overcome its decline are among projects being undertaken by Sea Grant scientists at the Virginia Institute of Marine Science (VIMS) following a $450,000 NOAA grant.

The Federal grant will be augmented by $285,000 in non-Federal funds.

Among the key projects being carried out at VIMS are studies into the development of an artificial feed for use in the culture of oysters, and the use of a device which may permit the "setting" of oyster seed without high mortality rates from predators.

In previous research work, VIMS scientists have made significant technological advances in the design and operation of a commercial hatchery system. The scientists also have developed new strains of fast-growing, well-shaped, and disease-resistant oysters.

Sightseers Stranded

Three Rescued From Island Off Florida

AMC Coastal Mapping Photo Party 65, headed by Lt. Donald L. Drake, rescued three persons, one of them a two-year old child, who had been stranded overnight on deserted Little St. George Island near Apalachicola, Fla.

The three persons, who had gone sightseeing the day before in a flat-back canoe, had left the canoe on the bay side of the island and walked across to the lighthouse. When they returned to the boat, the wind had become too strong for them to leave the island, and they had to spend the night without fire, camping gear, or food.

Lt. Drake

Drake and George Cole, Chief of Coastal Mapping Division, Florida's Department of Natural Resources, were recovering bench marks when they heard a call for help from the other side of the flowing channel.

Cole and Drake launched their 12-foot JON boat and approached the lee side of the island, which is uninhabited except for goats and pigs. After rescuing the three people and the canoe, they continued with the reconnaissance of Cape St. George where a secondary Tide Station will be installed to help delineate the United States 200-mile boundary limit.

After more than 30 years

Townsend Leaves Government

After more than 30 years with the Government, Dr. John W. Townsend, Jr. concluded his Federal service on January 30, 1977, and took a position in private industry. Dr. Townsend had served as Associate Administrator since 1970, and for two years as Deputy Administrator of NOAA's predecessor, Environmental Science Services Administration.

Dr. Townsend

Dr. Hess

Dr. Wilmot N. Hess, Director of NOAA's Environmental Research Laboratories in Boulder, Colo., has been named as Acting Associate Administrator.

Dr. Townsend brought to his NOAA assignment a broad background of educational achievement and research in atmospheric and space sciences.

A native of Washington, D.C., he graduated from Williams College in 1947, with honors, and with highest honors in physics. In 1949, he received his masters' degree in physics, and in 1961, an honorary degree from Williams.

From 1949 to 1958, Dr. Townsend was with the Naval Research Laboratory, where he participated in programs designed to probe the secrets of the highest levels of the atmosphere.

As head of NRL's Rocketsonde Branch and Deputy Science Program Coordinator for Project Vanguard, he directed the preparation of scientific instrumentation for two of the four original earth satellites.

Dr. Townsend transferred to NASA in 1958 as Chief, Space Sciences Division. The following year he became Assistant Director of Goddard Space Flight Center, and was appointed Deputy Director in July, 1965.

At Goddard, he was responsible for the day-to-day management of most of NASA's scientific and applications satellites, its global tracking and data acquisition network for unmanned satellites, and the manned Gemini and Apollo spacecraft.

Dr. Townsend's distinguished career brought him much recognition. He received the Navy's Meritorious Civilian Service Award, the NASA Medal for Outstanding Leadership, the Arthur S. Flemming Award as one of the Ten Outstanding Men in the Federal Service, and the NASA Distinguished Service Medal.

Dr. Hess was Director of Science and Applications for NASA when he was named head of what is now ERL in 1969. Before joining NASA, he directed the University of California's Lawrence Livermore Radiation Laboratory from 1954 to 1964.

Dr. Hess, a native of Oberlin, Ohio, earned his Ph.D. degree in physics at the University of California in 1954. He has received many professional awards. Among his professional memberships are the American Meteorological Society, American Physical Service, and American Association for the Advancement of Science. He is a Fellow of the American Geophysical Union.

Minnesota Is Awarded Coastal Grant

The State of Minnesota has been awarded a $120,000 grant to continue developing a coastal management program. The grant covers a six-month period and will be administered by the State Planning Agency.

The management program is designed to supply technical, financial, and legal information on which to base decisions on the future land and water uses in the coastal area.

Minnesota has been developing its program since 1974 when the state received an initial NOAA grant for $9,500.

The first six months of Minnesota's third year effort will be devoted to completing substantive elements of the management program, including the coastal uses and boundary, the geographic areas of particular concern, and the implementing authorities and organization structure.

Weather Computer At GFDL

NOAA now has put the world's fastest fully-operational computer to work on one of the world's most complicated problems—understanding and predicting weather and climate.

The "Advanced Scientific Computer," the only one of its kind in existence, is running at full capacity at the Geophysical Fluid Dynamics Laboratory in Princeton, N.J., following installation, refinements, and modifications that have taken more than a year to accomplish. ERL scientists at the Princeton laboratory use the computer to construct and test numerical models of the atmosphere, oceans, and all the complex processes that determine the weather.

The new computer can perform 50 million additions per second, two to five times faster than any previous computer. Its central memory can store one million words.

This enormous capacity is necessary for the work of the laboratory, constructing computer models for the earth's atmosphere and oceans, and for a multitude of smaller-scale phenomena, such as hurricanes, jet streams, and ocean currents.

With the computer, a mathematical universe can be set in motion, enabling the scientists to see how well their model simulates the behavior of the real atmosphere or predicts the effects of a change in the system, such as a decrease in stratospheric ozone.

New members of the National Advisory Committee on Oceans and Atmosphere (NACOA) are sworn in by Committee Chairman William J. Hargis, Jr., in ceremonies at the Department of Commerce. Left to right are: John A. McWilliams, General Manager and Chief Executive Officer, Toledo-Lucas County Port Authority; Dr. Alfred A. Keil, Dean of Engineering, MIT; John N. Garner of Everett, Wash.; former Congressman Herman T. Schneebeli of Williamsport, Pa.; Chairman Hargis; former Presidential counsellor Michael Raoul-Duval of Washington; NOAA Deputy Administrator Howard W. Pollock; Washington Attorney J. Robinson West; and John R. Michaels, President, Michaels Development Co., Boston. New members Lawrence J. Hogan and George M. Sullivan were not present when the photograph was taken.

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Abel Leaves NOAA; New SG Director

Dr. Robert B. Abel, for nearly a decade Director of the Office of Sea Grant Programs, will become Assistant Vice President for Marine Affairs at Texas A&M University.

Over the last two months, Dr. Abel has served as Special Assistant to the Administrator for University Affairs, and during that time has undertaken a study concerning NOAA's relationships, present and future, with the university community.

NOAA has traditionally depended upon universities to carry out certain research and advanced development in support of its mission. Largest of these efforts has been the National Sea Grant Program, under the direction of Dr. Abel. Other NOAA elements also support university research and development, in such sciences as atmospherics, fisheries, and appropriate fields of public policy including coastal zone planning.

"Bob Abel's contribution to his country and to our organization have been of major importance," Dr. White said. "In going to the distinguished institution which will be his new professional home, he will continue that tradition. Our thanks and good wishes will go with him."

Sea Grant's new director, Dr. Ostenso, had managed a Navy contract research program in physical oceanography, air-sea interaction, marine geology and geophysics, and ocean technology since 1971.

His educational background includes a Bachelor of Science degree in 1952, a Master of Science degree in 1953, and a Doctorate in 1962, all from the University of Wisconsin.

In 1953 he joined Woods Hole Oceanographic Institution as a research assistant. He has served as commander of a meteorological research and development team at the Army Arctic Center, and conducted seismology, glaciology and gravity studies in Greenland for Lamont Geological Observatory. From 1956 to 1966, he was with the University of Wisconsin.

In 1966, he joined the Office of Naval Research as a physical science coordinator and later became program director for marine geology and geophysics.

Calling the new Office of University Affairs "a window on NOAA for the university community," Dr. Robert M. White, Administrator, explained the reorganization was prompted partly because NOAA's support of the university-based research and development had grown to more than $33 million annually in oceanic and atmospheric sciences, fisheries, earth sciences and public policy.

Meteorologist-in-Charge Melvin Hull plays a NOAA Weather Radio transmission for guests at dedication ceremonies for the new service to the southern Oregon-northern California coasts. Others on stage for the Brookings, Oreg., ceremony were (from left) Lois King, an emissary of California Congressman Don H. Clausen; Crescent City (Calif.) Mayor Robert Brown; and Brookings Mayor Robert Kerr.

Rhode Island Receives Coastal Planning Grant

The State of Rhode Island has been awarded a six-month supplemental grant of $238,000 by NOAA to assist in preparing a coastal management plan that will meet requirements of the Federal Coastal Zone Management Act.

Rhode Island began developing its program in 1969, and received an initial planning grant of $154,000 from NOAA in 1973.

The Coastal Resources Management Council has been managing Rhode Island coastal resources since 1971 by issuing permits for all shoreline and state water activities. The Council is a group of 17 citizens appointed by state and local officials.

NOAA had made the latest award at the request of the state to supplement an earlier grant of $192,779, also for six months. Under the Coastal Zone Management Act, Rhode Island will add $59,500 in state matching funds.

According to the State, the supplemental funds will be used to refine a draft program presented to the public at special hearings last spring and summer, and to begin work on three new elements required by the Coastal Zone Management Act Amendments of 1976. Those elements are Energy Facility Siting Planning, Shoreline Erosion Control, and Shoreline and Beach Access.

Dr. Ned A. Ostenso (seated) signs a $1,475,000 Sea Grant to the University of Washington as Administrative Officer Charles Miller looks on. The grant was the first signed by Dr. Ostenso since he assumed duties as Director of the National Sea Grant Program.

Councils Receive Grants

A total of $443,100 has been alloted to three of the Nation's eight Regional Fishery Management Councils for administration and management plan development.

The Pacific, Western Pacific, and South Atlantic Regional Fishery Management Councils were allotted $141,200, $160,400, and $141,500, respectively, the first of such grants under the Fishery Conservation and Management Act (FCMA) of 1976.

Commonly referred to as the "200-mile limit," the landmark legislation, which became effective March 1, 1977, established Regional Fishery Management Councils each of which is required to prepare a management plan on each fishery in its geographical area, to prepare comments on any application for foreign fishing, to conduct public hearings, and to make periodic reports.

In related action, three of the Regional Fishery Management Councils have established scientific and statistical committees authorized by the FCMA.

A scientific and statistical committee assists in the development, collection, and evaluation of statistical, biological, economic, social, and other scientific information pertaining to the development and amendment of any fishery management plan.

Scientific and statistical committees (SSC) have been chartered in accordance with the Federal Advisory Committee Act by the Pacific, North Pacific, and Western Pacific Fishery Management Councils. Additional committees are being established by the Gulf of Mexico and Caribbean Councils.

As required by the FCMA, each council will ultimately have a SSC. The size and number of subcommittees of the SSC's depend on the number of fisheries to be managed and the complexity of the fishery problems.

NOS Publishes 37 Updated Charts

The National Ocean Survey has announced publication of new editions of 19 nautical charts for the West Coast, Hawaii and Alaska and 18 nautical charts for the Atlantic Coast and Great Lakes.

Charts may be obtained from the National Ocean Survey, Distribution Division, (C44), Riverdale, Md. 20840.

Fish Grade Standards Proposed by NMFS

General standards for grades of fish fillets, to permit determination and identification of their quality at the marketplace, are being developed under interim regulations proposed by the National Marine Fisheries Service.

The proposed general quality standards will cover fresh and frozen fish fillets of all commercial marine and freshwater species except cod, flounder and sole, haddock, ocean perch and Pacific Ocean perch, which are already covered under specific U.S. standards.

Grades are designated as U.S. Grade A, B, and C, and the standard will permit them to appear on the product or product label of all qualified fillets inspected, graded, and certified by NMFS.

The proposed regulations contain four sections: product description, product forms, grades, and grade determination. In determining Grade A, for example, fish fillets must have good flavor, texture, and odor characteristic of the species; Grade B quality must be reasonably good for these product attributes; and Grade C quality must be acceptable for human consumption among other things.

The grades will be determined by evaluating the product in the fresh, thawed, and cooked states. NMFS is using the proposed interim general standards for fish fillets in its voluntary program of fishery products inspection and certification.

NOAA Aircraft Flies Relief Mission

NOAA's C–130 "flying laboratory" turned a research flight past Pacific Hurricane Madeline into the first relief mission into a coastal town isolated by the storm.

While flying the Madeline mission the NOAA aircraft received a distress call from the airport at Zihuantenejo, about 120 miles (190 kilometers) northwest of Acapulco. The message reported the hurricane had knocked out municipal power and caused widespread damage. The storm had also reduced Zihuantenejo's airport to auxiliary power, so that, with night approaching, its only lights were those along the runway, restricting mercy flights into the stricken area.

Back at Acapulco, the NOAA airplane picked up six technicians and seven hundred pounds of supplies, and took off again for Zihuantenejo. Half an hour later the big ship, linked to Zihuantenejo's controllers by an interpreter on board, touched down on the barely lighted strip. It left the six technicians and their supplies there, to get the airport ready to receive the relief flights that would follow. It also left 13 cases of emergency rations the airplane carries as survival gear.

The Madeline mission that brought the NOAA research plane to Mexico was a series of low-level passes behind the hurricane as it moved on the coast. On these passes, scientists aboard the plane dropped airborne expendable bathythermographs—instruments which sense changes in ocean water-temperature with depth—to measure the amount of upwelling behind the storm.

This hurricane "cold wake" phenomenon, NOAA scientists believe, is an important indicator of how a storm affects the ocean it traverses, and perhaps how successfully it survives at sea. And, because upwelling brings nutrients to the surface, the phenomenon may also create transient fisheries along the track of the storm.

US/Mexico Sign Fish Agreement

The National Marine Fisheries Service has announced an agreement between the United States and Mexico providing limited U.S. fishing activities within Mexico's 200-mile economic zone. The agreement was signed by Ambassador John Jova for the United States and by Foreign Minister Alfonso Garcia Robles for Mexico, and now is in effect.

The agreement authorizes limited access for U.S. fishermen to traditional fisheries within 12 miles of the west coast of Mexico. U.S. vessels are also authorized to harvest surplus portions of the total allowable catch, determined by Mexico, of snapper and grouper, shrimp, and associated incidental fishes within the 12- to 200-mile zone off Mexico's Gulf coast. Moreover, continuation of the U.S. fishery for highly migratory species in that zone is permitted.

The United States has accepted the concept of phase down-phase out regarding its shrimp fishery within the Mexican 12-200-mile zone.

U.S. vessels will fish only on the Contoy and Tampico grounds, with no more than 80 percent of the catch being taken off Tampico. Each vessel participating in the fishery will pay annually a permit fee of $80 and a charge of $2,006 for its yearly catch, calculated on the basis of five percent of the official price for shrimp (as established by Mexico) of $4,640 per ton.

Vessels that intend to fish off Contoy will pay a yearly catch charge of $1,538, since the fishery in this area has yielded, on the average, 35 percent rock shrimp. The official price for rock shrimp is $1,540 per ton.

The agreement provides for 52 U.S. vessels to participate in the hook and line fisheries within the Mexican zone until the annual allocation of 450 metric tons is taken.

NEW FILM CATALOG ISSUED BY NOAA

A catalog listing more than 50 motion picture films on such diverse subjects as ocean and weather research, precautions to take in the event of severe storms, commercial fishing practices and the preparation of seafood, and the coastal environment is available from NOAA.

Produced by the NOAA Motion Picture Service, the films are intended for general public viewing. All are 16mm, and most are in color. They run up to 48 minutes in length.

The films are available on a loan basis, without charge.

Copies of the catalog may be obtained from Motion Picture Service, NOAA, 12231 Wilkins Avenue, Rockville, Md. 20852. Film ordering instructions are included in the catalog.

Secretary Appoints SG Panel

Secretary of Commerce Juanita M. Kreps has announced the appointment of 14 members of NOAA's first Sea Grant Review Panel.

The new panel, which succeeds the former Sea Grant Advisory Panel, is made up of 15 voting members especially qualified to advise the Secretary of Commerce and NOAA on the marine-related research, education, and advisory service activities of almost three dozen institutions across the country supported by the National Sea Grant Program. The panel members have been drawn from a wide variety of academic, business, and legislative backgrounds. The fifteenth panel member is expected to be named later this month.

One-third of the Panel's members have been appointed to one-year terms, one-third appointed to two-year terms, and one-third appointed to three-year terms.

Antitumor Cancer Research Underway

The American Cancer Research Center and Hospital in Lakewood, Colo., and the Ohio State University Foundation in Columbus, Ohio, have received separate but related grants from NOAA's Office of Sea Grant to conduct chemical investigations of a marine antitumor substance.

NOAA's $25,000 grant to the Colorado hospital will be matched by $67,000 in non-Federal funds. Ohio State will receive a grant of $16,200 with the University pledging more than $8,000 in matching funds.

Sea Grant-supported researchers at both institutions will be studying the ordinary hard shell clam in hopes of purifying and identifying a substance from the clam's liver that is active against tumors found in mammals.

Dr. A.C. Schmeer, director of the American Cancer Research Center's program on anticancer agents of marine origin, will extract the as-yet-unidentified biologically active substance from the clam's livers. The crude extract will then be shipped to Dr. Derek Horton at Ohio State's chemistry department, where it will be purified and identified.

According to Dr. Horton, once the antitumor chemical is identified, an attempt will be made to synthesize it in the laboratory. Purified preparation of the natural clam extract will be applied to the Drug Research and Development division of the National Cancer Institute for further testing and study.

US/USSR Scientists Develop Finfish Resource Survey Program

More than 200 American and Russian scientists, officers, and ship crews have helped to develop a research vessel survey program that can provide annual inventories of finfish resources. A total of 13 research vessels from both nations have made 49 cruises as part of the program.

Underway since 1967, the joint fisheries research provides a model for a coordinated survey program for the 18 member nations of the International Commission for the Northwest Atlantic Fisheries (ICNAF).

Research vessel data on species distribution and abundance have now become a vital part of the data base used for stock assessment for the entire ICNAF area (the Northwest Atlantic Ocean). Approximately 100 major studies have been generated entirely or in part by the accumulated data.

The bilateral effort provided the first estimates of such population data as growth and mortality for major species like cod, silver hake, red hake, yellowtail flounder, and redfish.

The United States and the Soviet Union undertook the cooperative program as an essential part of a 1967 bilateral fisheries management agreement dealing with the fisheries resources of the Northwest Atlantic Ocean.

Throughout the decade, the surveys and related studies on the fishing power of various trawls were the key elements of the program. The program included studies on the development of fish stock surveys, and on the spawning growth, feeding, and mortality of major species.

American scientists and vessels came primarily from NOAA's Northeast Fisheries Center in Woods Hole, Mass. Soviet scientists and vessels came primarily from the Atlantic Research Institute of Marine Fisheries and Oceanography in Kaliningrad on the Baltic Sea.

Great Lakes Pilot Update Scheduled

NOAA will begin the first full inspection of marine and navigational facilities of the Great Lakes, the upper Hudson River, U.S. part of St. Lawrence Seaway, and the New York Barge Canal, on May 1.

The inspection is being made to revise the U.S. Great Lakes Pilot, a publication issued for commercial shipping, government vessels, and recreational boating by the National Ocean Survey.

The Pilot supplements the navigation information shown on standard nautical charts by furnishing details that cannot be shown graphically on marine charts such as channel and anchorage peculiarities, navigation regulations, weather, port facilities, and prominent landmarks.

Conducting the first four months of the inspection for the National Ocean Survey is NOAA Corps Lt. Pamela R. Chelgren of Seattle, Wash., who will meet with officials of the U.S. Coast Guard, U.S. Army Corps of Engineers, pilotage associations, port authorities, harbormasters, State Fish and Game, and others involved in marine affairs and regulations.

Total Now a Dozen

MIT Designated SG College

The Massachusetts Institute of Technology has been designated a Sea Grant College in recognition of the school's excellent marine program.

The addition of the prestigious Cambridge, Mass., institution brings to 12 the number of Sea Grant Colleges named since the National Sea Grant Program began in 1966. MIT also becomes the first private institution to join the ranks of Sea Grant Colleges.

In recognition of the excellence of a university's Sea Grant-supported marine program, the Secretary of Commerce may confer Sea Grant College status.

Among MIT's most recent accomplishments was the design last year of a novel hook-up block for use in trawling operations on New England fishing boats, which allows nets to be hauled back more quickly and efficiently. The device is significantly safer than the traditional hook-up block, which has caused serious injury, and even death, among fishermen in the Northeast.

Lt. Chelgren

In 1973, MIT's Sea Grant program produced a major study of the environmental and economic impacts of potential oil and gas development on Georges Banks, an area on the continental shelf off New England. The study is now being used by regulatory agencies and the oil industry as a reference for base-line information.

Related work by MIT scientists on oil spill tracing, containment, and removal has contributed towards reducing the hazards of petroleum operations.

Last July, MIT received a grant of more than $1 million from the Office of Sea Grant. The money, matched by some $780,000 from non-Federal sources, is being used for a variety of marine projects including an effort to improve the techniques used in welding and cutting material underwater.

Working with engineers and technicians in Western European countries, the MIT researchers are studying such aspects as heat flow and metal transfer as well as the effects of water on the structure of welds. According to the scientists, the techniques are extremely important in view of the increasing number of offshore structures that need periodic repair.

400-Horsepower Thruster

NOAA Ship Miller Freeman Receives New Push

The National Ocean Survey recently installed a 400-horsepower, retractable bow thruster in the NOAA Ship Miller Freeman, one of the largest stern trawlers in the United States.

A spokesman for the NOS Office of Fleet Operations said the bow thruster is an "auxiliary propulsion device that extends five feet below the bow of the Miller Freeman and rotates 360 degrees to deliver 11,000 pounds of thrust in any direction.

The bow thruster allows the ship full maneuvering capability with its main engines shut down, including station holding and docking in confined areas. The thruster can also be used as emergency propulsion in case of main engine failure and will propel the ship at six knots.

The Miller Freeman is commanded by Cdr. S.R. Petersen.

NMFS Issues A Permit To Import Sealskins

A permit to import 13,000 Cape fur sealskins from the Republic of South Africa has been issued to the Fouke Fur Company, Greenville, S.C., by the National Marine Fisheries Service.

The importation will be permitted only if a number of specified conditions are met.

Importation of marine mammals or marine mammal parts is prohibited by the Marine Mammal Protection Act of 1972. However, the Act authorizes a waiver of the moratorium when it is determined on the basis of the best scientific evidence available that the taking of the marine mammals is in accord with sound principles of resource protection and conservation.

This is the first permit granted by NOAA to import South African skins under a 1975 waiver of the moratorium placed on the importation of all marine mammals and marine mammal products by the Marine Mammal Protection Act.

noaa/people

Charles H. Sprinkle has been named chief of the Aviation Branch, Meteorological Services Division at NWS Headquarters in Silver Spring, Md. He succeeds **Stanley J. Lacy** who recently retired.

Dr. Mikhail A. Alaka has assumed the duties of Deputy Director of the Techniques Development Laboratory, Systems Development Office, NWS. He is also Chief, Special Projects Branch, TDL, a position he has held since 1967.

Captain Sidney C. Miller has been appointed Commanding Officer of the NOAA Ship Discoverer.

Samuel S. Ross has been selected as NOAA's EEO Counselor, Equal Employment Opportunity Office, in Rockville, Md.

Captain Wesley V. Hull has been appointed Chief, Oceanographic Division, of the Office of Marine Surveys and Maps in Rockville, Md.

Donald R. Wiesnet, Sr., Research Hydrologist with the National Environmental Satellite Service has recently been appointed a member of the Commission on Snow and Ice of the American Geophysical Union. Mr. Wiesnet is also a contributing author to a new book published by John Wiley & Sons entitled "Facets of Hydrology" compiled by Dr. John Rodda of the British Department of the Environment.

Cecilia Griffith, Physicist, National Hurricane Experimental Meteorological Labs and **Ethel Howard** Meteorological Technician, WSMO, National Hurricane Center, were on a taped interview show for TV Channel 6 WCIX, Miami, Fla., called "Black Involvement" recently. The panel consisted of members of Federally Employed Women.

W. Gale Haggard is the new Executive Officer to the Director, Systems Development Office, National Weather Service Headquarters in Silver Spring, Maryland. He succeeds **Vincent S. Murino,** who is now Chief, Executive Affairs Staff, NWS.

Dr. Harris B. Stewart, Jr., Director of the ERL Atlantic Oceanographic and Meteorological Laboratories, has been appointed the U.S. National Associate to the Intergovernmental Oceanographic Commission's Caribbean Regional Association. This is the successor body to CICAR which terminated last July.

Robert S. Lawrence, a physicist with ERL has been elected a Fellow of the Optical Society of America, a technical society devoted to increasing and diffusing the knowledge of optics in all its branches. Only individuals who have served with distinction in the advancement of optics are eligible for election to the class of Fellow.

The National Ocean Survey 1977 Outstanding Employee of the Year Award was recently presented by R. Adm. Allen L. Powell (left), at NOS Headquarters in Rockville, to Ralph Pekinpaugh of Tell City, Ind., as Mrs. Pekinpaugh looks on. Mr. Pekinpaugh designed an easily managed portable station tower, and a truck-mounted observing tower.

Dr. Russell Schnell, Post-doctoral Fellow with ERL's Atmospheric Physics and Chemistry Laboratory, has been elected by the National Academy of Sciences as a member to the Committee on Aerobiology. Dr. Schnell, presently on assignment from the World Meteorological Organization, is organizing aerosol research in Kenya, Africa.

Paul E. Atkinson, president of Sun Shipbuilding and Dry Dock Company, in Chester, Pa., has been honored with the 1976 Sea Grant Award. With the presentation at the ninth annual meeting of the National Sea Grant Association in Los Angeles, Atkinson became the first person from industry to receive the award.

Cdr. Melvin J. Umbach is the new commanding officer of the NOAA Ship Mt Mitchell.

Cdr. Carl W. Fisher is the new commanding officer of the NOAA Ship Peirce.

J. Virginia Lincoln, a physicist with the Environmental Research Laboratories in Boulder, Colo., and **Dr. Joanne Simpson** a former NOAA meteorologist in Miami, have been nominated for the Woman of the Year Award by the editors of the *Ladies Home Journal* magazine.

Ralph Pekinpaugh of Tell City, Ind., has received the NOS 1977 Outstanding Employee of the Year Award.

Atlantic Marine Center Director, R. Adm. Robert C. Munson (center) recently boarded the NOAA Ship George B. Kelez to present the Karo Award to the officers and crew for superior performance on the MESA New York Bight Project. Accepting on the ship's behalf is her CO, Lt. Cdr. John DeCoste (right) and Executive Officer, Lt. Cdr. Michael Kawka.

Dr. Arthur N. Hull has been appointed Meteorologist in Charge of the Weather Service Forecast Office, Seattle, Wash. Dr. Hull replaces **A. L. Zimmerman** who retired in August.

Donald E. Boggs has been named Official in Charge of the Weather Service Office in Goodland, Kans., succeeding **Warren Eckert** who recently retired.

Daniel G. Houser has been appointed Meteorologist in Charge of the Weather Service Office in Lansing, Mich., succeeding **Bob Babb** who recently retired.

Frank Nishimoto of the Weather Service Forecast Office, Portland, Oreg., recently received a Bronze Medal Award.

Dr. John Apel, Director of the ERL Pacific Marine Environmental Laboratory in Seattle, Wash., was a member of a group of 15 researchers that visited Novosibirsk in the Soviet Union.

Daniel J. Twohig, Electronics Technician at the Northwest and Alaska Fisheries Center, has been named the first recipient of the NMFS Outstanding Employee of the Year Award.

Marvin Hofer of the San Francisco Weather Service Forecast Office recently was awarded a Bronze Medal.

Dr. Rudolf Pueschel, a physicist with the ERL Atmospheric Physics and Chemistry Laboratory, visited West Germany, Libya, Jordan, Saudi Arabia, Sudan, Ethiopa, and Kenya to advise meteorological services in those nations on the establishment of stations for monitoring aerosols and atmospheric chemistry components.

Dr. Donald C. Malins, Director of the Division of Environmental Conservation at the Northwest and Alaska Fisheries Center in Seattle, Wash., has been awarded the degree of Doctor of Science from the University of Aberdeen in Scotland.

Doyle Cook has been selected Meteorologist in Charge of the Weather Service Forecast Office at Charleston, W. Va.

Rolf Juhl, Laboratory Director of the NMFS Southeast Fisheries Center in Pascagoula, Miss., has been appointed United States Regional Fisheries Attache for Latin America.

Wayne McCarter has been appointed Meteorologist in Charge of the Yuma, Ariz., Weather Service Office. He replaces **Victor Cotten** who retired.

Lieutenant David J. Tennesen has been awarded the NOAA Corps Diving Pin.

Roy C. Brown has been named Deputy Chief, Personnel for NOAA.

noaa/update

NOS Publishes Florida Coast Evacuation Maps

Four storm evacuation maps covering a wide area along 110 miles of Florida's east coast from Key Largo to Juno Beach north of West Palm Beach, have been published by the National Ocean Survey.

Designed to help evacuate persons from endangered areas, the maps, covering Miami, Fla., and vicinity, show emergency evacuation routes, flood-prone areas, and elevations which might afford "safe islands" for evacuees.

The four maps include parts of Dade, Broward, and Palm Beach counties in which three of the most popular vacation spots in the nation—Miami Beach, Fort Lauderdale, and Palm Beach—are located. Numerous smaller beaches and other points of public interest such as Biscayne Bay and the eastern part of the Everglades National Park are covered. The National Weather Service distributes the storm-evacuation maps to state and local officials and community emergency preparedness committees.

The detailed maps include areas subject to flooding by surges of various heights; main evacuation roads and feeder roads; low points along the roads that might be engulfed; and high spots which are likely to remain unaffected by flood waters.

BLM and NOAA Sign Agreements

Officials from NOAA and the Interior Department's Bureau of Land Management have signed agreements governing environmental studies being carried out on the impact of oil exploration and development on Alaska's outer continental shelf. Among the documents signed at the Washington, D.C. meeting were a new basic agreement between the two agencies defining policies and responsibilities in this program, a program development plan, and an interagency agreement transferring some $14.1 million in funds.

NACOA Study

Sea Grant Program Held Beneficial

Gary D. Pruder, Research Engineer at the University of Delaware, checks experimental oysters in a new growing rack apparatus as part of the successful mariculture work underway at the university's College of Marine Studies on the Lewes campus, sponsored by the National Sea Grant Program.

Following a year-long study, the National Advisory Committee on Oceans and Atmosphere (NACOA) has concluded that the National Sea Grant Program has had a large, beneficial influence on the Nation's efforts to develop and manage its marine resources.

"It has done this," wrote Chairman William J. Hargis, Jr., in a letter to the Secretary of Commerce, "by providing a means for enlisting our universities and research institutions in the search for solutions to problems of commerce and government at all levels."

While the 78-page special report was complimentary toward the scope, purpose, and operation of the Sea Grant Program, it also offered recommendations for improvements in some areas, and strongly suggested that funding for the program, which was $23.1 million in Fiscal Year 1976, should be increased to a "minimum of $40 million per year within the next few years."

In addition to calling for increased funding, NACOA recommended allowing funds to be provided, free of matching, for national and international purposes identified at the Federal level. The Committee also favored elimination of an existing prohibition against using Federal funds to pay for ship time.

Other recommendations touched on the need to clarify the goals and the role of Sea Grant in the broad context of the overall national effort to develop, utilize, and protect marine resources, and to improve coordination with other related Federal programs.

In addition, the Committee recommended certain changes in the makeup and function of the Sea Grant Advisory Panel, development of a more expeditious proposal review procedure, and provision of clearer guidelines to assist participating institutions in establishing priorities.

Satellite Tapes Available From EDS Climatic Center

The Satellite Data Services Branch (SDSB) of EDS' National Climatic Center now can provide copies of magnetic tape containing Very High Resolution Radiometer (VHRR) data from the NOAA series of polar-orbiting satellites.

The VHRR data are collected by a scanner that has both visible and infrared channels with 1-km resolution. The image swaths extend 50 to 60 degrees of latitude along the orbital track. About 8 minutes ($^1/_{15}$th of a complete orbital track) of coverage in other parts of the world also may be programmed for storage aboard the satellite on some, but not all, orbital passes each day.

All NOAA series polar-orbiting satellite tapes are sent to Satellite Data Services Branch. The tapes will be held 90 days after the date of data collection. After 90 days the tapes will be erased. During the period that the tapes are maintained at SDSB, requesters will be provided copies of the tapes at cost of reproduction.

Requests for copies of any of these tapes should be addressed to Satellite Data Services Branch, World-Weather Building, Room 606, Washington, D.C., 20233.

New "Anglers' Guide to the United States Atlantic Coast" Published

A study of the location of marine recreational fishing grounds, the various fishing and boating facilities available, local conditions and characteristics of fishing, life habits, and environmental requirements of recreational fishes along the Atlantic coast has been published by the NMFS.

Entitled "Anglers' Guide to the United States Atlantic Coast" and issued in four sections, the publication covers saltwater fishing from Virginia to Florida. Its authors were Bruce L. Freeman and Lionel A. Walford of the National Marine Fisheries Service laboratory at Sandy Hook, N.J.

The new sections are the second half of an eight-section study which embodies the entire coast from Maine to Florida. The first four sections were published in 1974.

The published sections include sub-area maps of the tidal shoreline, indicating wetlands as well as city, county, and Federal parks and wildlife areas. Principal roads and towns, marinas, ramps, docks, and other fishing facilities are shown, as are fishing grounds, locations of wrecks, artificial reefs and areas to the edge of the Continental Shelf where the most popular fish are commonly caught. Illustrations of the fish available, along with brief descriptions of their habits, distributions, and seasons of abundance, are included. A text accompanying each section discusses topography, climate, tides, history of fishing, conservation problems, and some biology of the more frequently caught fish. Each section also contains a glossary of fisheries terms.

The Sections can be ordered from the Superintendant of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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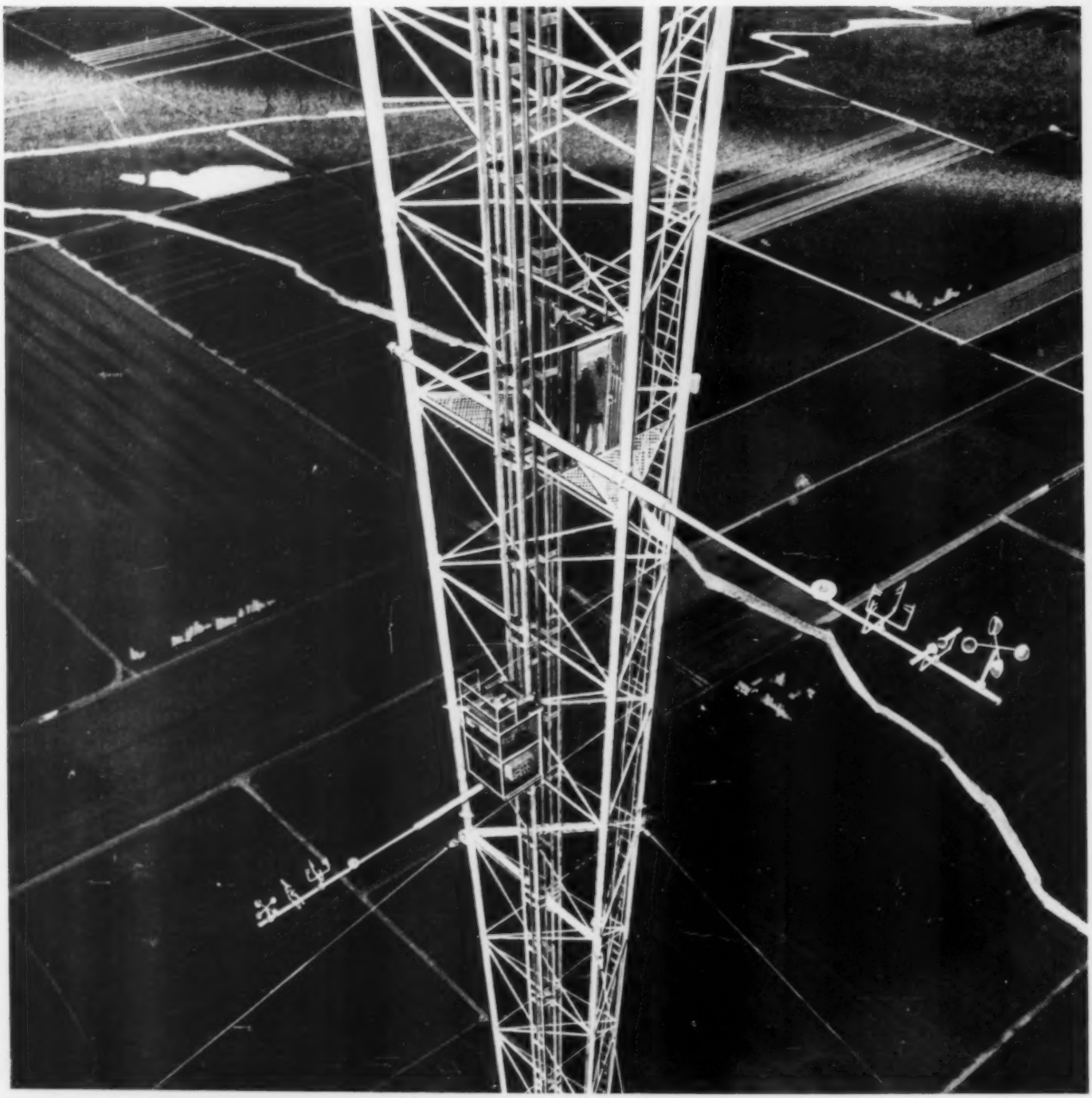

For story see page 22.

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